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Faith in Educational Exchanges

The increase in international educational exchanges since the close of World War II is an important development of American foreign policy. Most of us share the general impression that the exchange of persons is a good thing. The Department of State's recent publication celebrating the 10th anniversary of the Fulbright Act confirms this impression and promises a bright future. But exchange is not without serious problems, and the successes so far achieved have not come easily.

One of the fundamental problems is to determine the degree of control that the Government should retain in the various programs it sponsors. Two positions are taken. The first accepts the thesis that educational exchange is a part of foreign policy but maintains that it is foreign policy with faith—the faith that, in the long run, mutual understanding among nations will be furthered when people from different cultures meet in pursuit of educational goals. The other position is more hardheaded. It holds that the Government does not belong in the exchange business unless it can make sure that the money spent is serving our national security, in the present case by creating a favorable attitude toward our values and policies.

The two principal Government-sponsored exchanges are the Fulbright Program of 1946 and the Smith-Mundt Program, which in 1948 broadened exchange activities to include other kinds of grants and non-Fulbright countries. The two programs are based on the opposing theories of governmental control. The difference, as reflected in administrative machinery, is best illustrated by considering who, in each program, has final responsibility for the selection of grantees. In the Fulbright Program, this responsibility rests with the Board of Foreign Scholarships, whose ten members are appointed by the President, two from Government offices, but the rest from academic and other private professions. In the Smith-Mundt Program, the responsibility lies in the Department of State. This is not to criticize the valuable administrative assistance the Department of State gives both programs. The points at issue are the special interests and commitments of the people who make the appointments and the effect of the locus of power on foreign opinion.

Which of the two views of the role of government will prevail is by no means settled. In a recently published report, Walter Johnson, of the University of Chicago, former chairman of the Board of Foreign Scholarships, stressed that people in other countries are sensitive to our power and that foreign critics are prepared to interpret exchanges as a form of propaganda. But he goes on to say that the administrative arrangements of the Fulbright Program did much to allay foreign suspicion.

We suggest that the philosophy of educational exchange underlying the Fulbright Program is the superior one. True, the proposition that good will is best sought indirectly through the pursuit of other activities may be an article of faith. But it is a matter of experience that this faith itself helps create good will.—J. T.

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Enzymatic Oxidation of Urate

H. R. Mahler, Harold M. Baum, Georg Hübscher

Although the enzyme uricase (uricooxidase) has now been known for some 50 years (*1*) and numerous extensive purification procedures have been described in the literature (*2, 3*), its mode of action and even the exact nature of the reaction it catalyzes has remained somewhat obscure until fairly recently. Investigations concerning the mechanism may be said to have had their inception with the demonstration by Schuler (*4*) that oxidation of urate (U^-) may occur without the simultaneous liberation of carbon dioxide. Praetorius (*5*) provided evidence that in nonborate buffers at least two short-lived but spectroscopically distinct complexes intervened between urate and allantoin, while a different path was followed in borate buffer. Bentley and Neuberger (*6*) showed conclusively by means of isotopic tracers that all the carbon dioxide had its origin in carbon atom No. 6 (C-6) of the uric acid molecule and that the enzyme functioned as an aerobic dehydrogenase, inasmuch as none of the oxygen used in the reaction was incorporated into the product allantoin. Thus, the reaction catalyzed by the enzyme was formulated as follows (*6*):

$$\begin{array}{l} \overset{-2e^-}{U^- \rightarrow U^+} \rightarrow I \rightarrow II \rightarrow \text{allantoin} + CO_2 \\ \qquad\quad \downarrow \text{borate} \\ \qquad\quad X \\ O_2 + 2e^- + 2H^+ \rightarrow H_2O_2 \end{array} \qquad (1)$$

The enzyme has now been obtained in good yield from pig-liver particles and purified to a state approaching homogeneity (*7*). Thus it has been possible to investigate several of the outstanding problems concerning its mode of action (*8*). This report is a summary and extension of some of these findings (*9*).

Active Site on the Enzyme

Uricase was identified as a cuproprotein containing 0.05 percent copper, corresponding to 1 gram atom of the metal per mole of enzyme (~ 120,000 grams). The metal is bonded very tenaciously by the enzyme protein and cannot be dissociated even in 5 percent trichloroacetic acid or by dialysis against strong copper-chelating agents (*10*). Thus it has not been possible to conduct experiments on the reversible dissociation of the holoenzyme and reactivation of the apoenzyme. Nevertheless, copper has been assigned as one of the sites binding the substrate to the enzyme on the basis of the following evidence. (i) There is parallelism of increase in copper content and specific enzymatic activity during purification (*7*). (ii) Urate, like other purines, is capable of chelation with metals (*11*); among these chelates, those of copper are among the most tightly bound (*12, 13*). (iii) The enzyme is inhibited by cyanide (*2*) and by other metal-complexing agents, which, like cyanide, are also capable of acting as reducing agents (*7*). (iv) These inhibitions are either completely or partially overcome in the presence of urate at low concentration (*7*). (v) The spectroscopically identifiable complex of diethyl,dithiocarbamate, copper, and enzyme, which is formed by dialysis of the enzyme against the chelating agent, is dissociated in the presence of urate. The linkage to copper is believed to be through chelate bonds to oxygen at C-6 and nitrogen atom No. 7 (N-7) by analogy with similar heterocyclic systems (*11*).

The kinetics of the enzyme-catalyzed reaction have been studied extensively, and some of the characteristic constants are summarized in Table 1. Additional linkage sites on the enzyme have been suggested from an examination of the *p*H dependence of the Michaelis constant and the maximal velocity (*14*) of the enzyme-catalyzed disappearance of urate. The two sites, one acidic and one basic, have pK_a's of 7.5 and 9.2, respectively, and have been tentatively identified as an α-amino and an ε-amino (or phenolic hydroxy) group of the protein (*12, 15*). Confirmation of this postulate and additional information have been derived from a study of the inhibition of enzymatic action exerted by a large number of 2,6,8-trisubstituted purines. This inhibition was found to be competitive to urate in all cases where it occurred at all (see Table 2) and thus permitted us to draw conclusions with respect to the structural parameters necessary for the formation of an effective enzyme-inhibitor complex.

Thus two binding sites, one cationic and linking the protein to the substituent at C-2, and one neutral, providing the link between protein and the substituent at C-8, have been identified. It is tempting to equate these two binding sites with the ε-amino (or phenolic hydroxyl) and α-amino group that we referred to in the previous paragraph.

Products and Intermediates

The availability of the highly purified enzyme has permitted us to establish the stoichiometry of the over-all reaction carried out by the enzyme. In phosphate or tris(hydroxymethyl)aminomethane buffers in the *p*H range between 7.0 and

Dr. Mahler, former assistant professor of enzyme research at the Institute for Enzyme Research, University of Wisconsin, is now on the staff of the department of chemistry at Indiana University. Dr. Baum and Dr. Hübscher were postdoctoral trainees of the National Heart Institute, National Institutes of Health, U.S. Public Health Service, at the Institute for Enzyme Research. Dr. Baum is now on the staff of the department of biochemistry, University of Cardiff, Wales. Dr. Hübscher is now on the staff of the department of pharmacology, University of Birmingham, England.

9.0, this stoichiometry is strictly that of reaction 2:

$$U^- + O_2 + 3H_2O \xrightarrow{\text{uricase}} \text{allantoin} \cdot H_2O_2 + HCO_3^- \quad (2)$$

The product is written as a stoichiometric complex of allantoin and hydrogen peroxide, inasmuch as mild treatment permits its isolation and recrystallization. Upon chromatography, solvent extraction or, most efficiently, treatment with catalase, the complex is decomposed with the resulting production of allantoin. In practice, for the large-scale isolation and identification of allantoin, the oxidation is performed in the presence of catalase and ethanol (*16*). Under these conditions the reaction measured becomes reaction 3:

$$U^- + \tfrac{1}{2}O_2 + \text{ethanol} + 2H_2O \xrightarrow[\text{catalase}]{\text{uricase}} \text{allantoin} + HCO_3^- + \text{acetaldehyde} \quad (3)$$

We have been able to confirm the complete conversion of urate C*-6 to $HC^*O_3^-$ (*6*) and the equally complete retention of C*-2 and C*-8 in allantoin (*17*).

In borate buffer, in addition to reaction 2, urate is oxidatively decomposed by alternative reactions. Cannelakis and Cohen (*19*) have shown that the other main reaction is as follows:

$$U^- + O_2 + 3H_2O \xrightarrow{\text{uricase}} UIDC^- + H_2O_2 \quad (4)$$

The product UIDC (5-ureido-2-imidazolidone-4,5-diol-4-carboxylate) is unstable, especially in the absence of borate, and decomposes according to reaction 5:

$$UIDC \longrightarrow \text{alloxanic acid} + \text{urea} \quad (5)$$

By the use of relatively rapid spectrophotometric techniques in studies of the possible intermediates during uric acid oxidation, we have made the following determinations. (i) The formation of intermediates I and II (*5*) is confirmed. (ii) At low urate concentrations, intermediate I is formed enzymatically by first-order kinetics; its rate of appearance equals exactly the rate of urate disappearance. (iii) When enzyme action is stopped—for example, in the presence of 10^{-3} *M* cyanide—the formation of intermediate I ceases immediately, and its rate of disappearance may then be studied without additional complications. (iv) Intermediate I is decomposed spontaneously and reversibly to intermediate II in a nonenzymatic reaction; this reaction is first order with respect to intermediate I and is *p*H-dependent. (v) Intermediate I is formed in borate buffer as well as in nonborate buffers, but its first-order rate of disappearance in the former is vastly enhanced, especially at moderate *p*H; II is not an intermediate in the borate-sensitive reaction. (vi) During the initial phases of the reaction in nonborate buffers, all the urate added can be accounted for as unchanged urate, as intermediate I, or as intermediate II (assuming approximately equal ε_{max} for all three compounds).

The ultraviolet absorption spectra of intermediates I and II have been studied in some detail. Intermediate I (λ_{max} = 305 mμ; $\varepsilon_{max} = \simeq 10{,}000$) shows two "spectrophotometrically operable" (*20*) ionizations with acid dissociation constants of approximately 4.5 (carboxyl group?) and $\geqq 11.5$. In the presence of divalent metals, especially Cu^{++} and Co^{++}, its rate of decomposition to intermediate II is greatly decreased ($t_{1/2} \geqq$ 20 min), presumably by formation of metal complexes. Neither the *pK*'s nor the spectrophotometric characteristics of the compound appear to be affected by this complex formation. Intermediate II ($\lambda_{max} = 260$ mμ; $\varepsilon_{max} \simeq 10{,}000$) also shows two "spectrophotometrically operable" ionizations. The pK_a's are 5.5 and $\geqq 12$. The transition owing to the latter ionization ($\varepsilon_{max} \simeq 30{,}000$ at 260 mμ) appears to be irreversible and leads to the destruction of the compound. An analogous spectrophotometrically observable transition is brought about by the addition of certain metals (Co^{++}, Ni^{++}, or Cu^{++}, but not Fe^{++}, Mg^{++}, or Mn^{++})

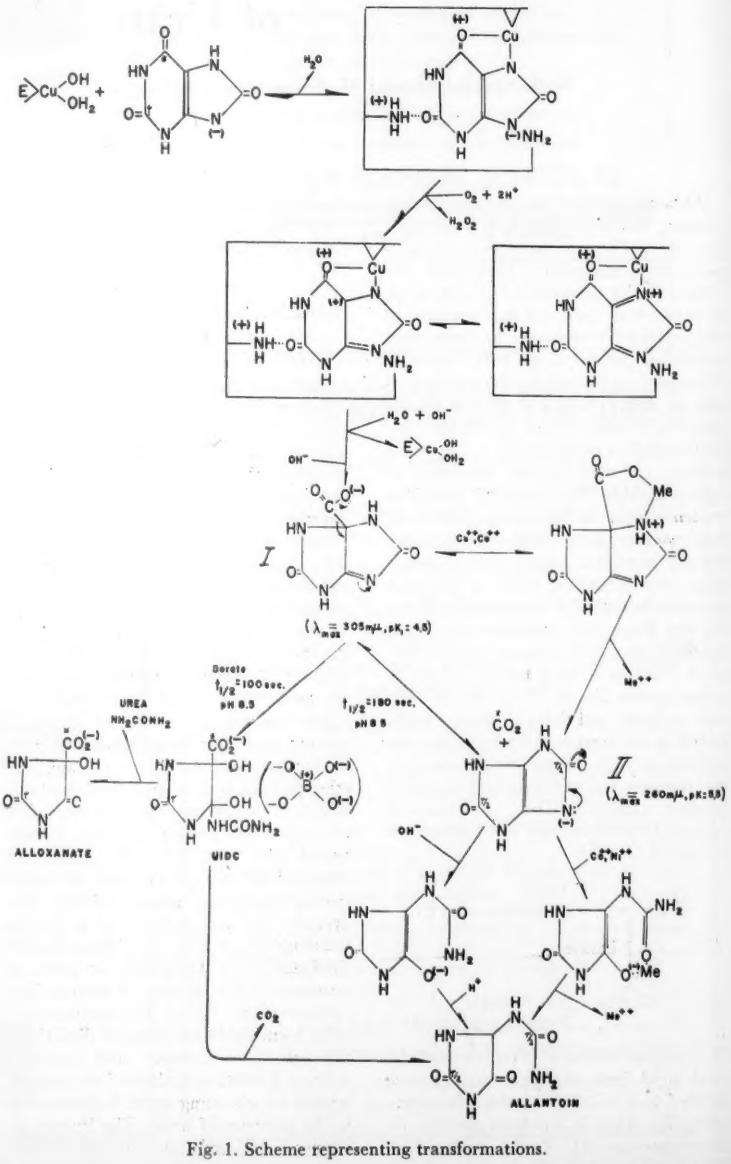
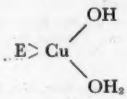


Fig. 1. Scheme representing transformations.

leading to the formation of reasonably stable metal chelates ($\lambda_{max} = 275$ mμ; $\varepsilon_{max} \simeq 30{,}000$).

Reactions Catalyzed by the Enzyme and Subsequent Chemical Events

It is believed that the scheme shown in Fig. 1, although it is speculative in certain instances, represents adequately the transformations described so far, and that it is based on reasonably firm experimental bases in the realms of enzyme chemistry, inorganic chemistry, and organic chemistry. Thus, the enzyme-copper complex is presented as



because, by analogy with the corresponding aqueo-complexes, this would appear to be the most reasonable structure in the pH range under consideration (*21*). It is also in accord with the pH dependences of the binding of urate and cyanide to the enzyme. The representation of the dehydrogenation reaction as leading from a carbanion to a carbonium ion is in accord with Bentley and Neuberger's postulate (*6, 18*), as are the ring-contraction reaction of the carbonium ion, a transformation amply documented in organic chemistry (*22*) (Wagner-Meerwein rearrangement), and the structure of intermediate I (Fig. 1). The reversible carboxylation reaction similarly is one not without precedent in organic chemistry (*23*), for it is analogous to the decarboxylations of β-ketonic acids (*24*). Numerous other compounds have been suggested as possible intermediates at one time or another. Of these, uric acid-5,6-glycol (*25*), 5-hydroxy-3,7-dioxo-2,4,6,8-tetraazabycyclo · (3,3,0) · octane-1-carboxylic acid (hydroxyacetylene diureido carboxylic acid, HDC) (*6, 18, 26*) and uroxanic acid (*27*) were prepared and tested under the reaction conditions used. They were all excluded as obligatory intermediates, since they were either stable or gave rise to products other than allantoin.

Mechanism of the Oxidation Reaction

The transfer of electrons from urate to oxygen as catalyzed by the enzyme presents an interesting problem. A possible mechanism would be the reversible reduction and reoxidation of the enzyme-bound copper. This was suggested as the most plausible mechanism for the analogous oxidations effected by other cupro-enzymes (*28*). This mechanism is probably not operative as such in the present case. Since there is only one copper atom per enzyme molecule, and since the kinetic measurements definitely suggest that a single enzyme-urate complex is involved in the rate-limiting step, this would entail the removal of 1 electron at a time from urate (*29*)—that is, the transformations summarized in reaction 6 involving the semiquinoid free radical U.

$$U^- + Cu^{++}E \rightleftharpoons [U^-Cu^{++}E] \rightarrow [U \cdot Cu^{+}E] \quad (6a)$$

$$[U \cdot Cu^{+}E] + O_2 \rightarrow [U \cdot Cu^{++}E] + O_2^- \quad (6b)$$

$$[U \cdot Cu^{++}E] \rightarrow [U^+Cu^{+}E] \rightarrow U^+ + Cu^{+}E \quad (6c)$$

$$Cu^{+}E + O_2^- \rightarrow Cu^{++}E + O_2^= \quad (6d)$$

Unless the affinity of the free radical for the enzyme is exceedingly great, one would expect the formation of rearrangement and polymerization (that is, dimers) products of urate. No evidence for such products has ever been obtained in the reaction under consideration. Another possible mechanism is one discovered by Chance for the hydroperoxidases (*30*) and suggested as being applicable to a variety of other dehydrogenation reactions as well (*31*).

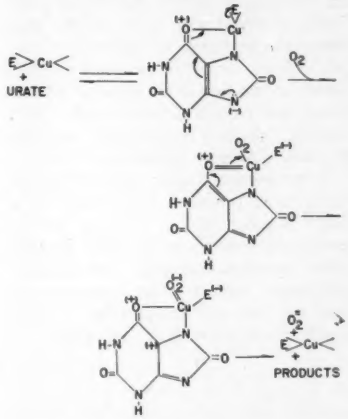
$$U^- + Cu^{++}E \rightleftharpoons [U^-Cu^{++}E] \quad (7a)$$

$$2H^+ + [U^-Cu^{++}E] + O_2 \rightarrow [U^+Cu^{++}E] + H_2O_2 \quad (7b)$$

$$[U^+Cu^{++}E] \rightleftharpoons U^+ + Cu^{++}E \quad (7c)$$

This mechanism has as a consequence the direct proportionality of K_s, the Michaelis constant for the substrate (urate), to the acceptor (O_2) concentration. This question has been investigated, and no such dependence has been found. As a matter of fact the K_s in pure oxygen was lower than the corresponding constant in air.

All the experiments on the kinetics of the oxidation of the only two substrates acted on by the enzyme—urate and 2,6-dioxy-8-aminopurine (the latter being oxidized at about 10^{-3} the rate of the former)—are consistent with the hypothesis that the actual electron transfer occurs within a ternary complex of substrate, enzyme, and acceptor. A possible elaboration of this hypothesis is presented in the following reaction.



The metal is probably in the oxidized form in the catalytically active complex. Substances that are capable of both complexing and reducing the copper from the cupric to the cuprous form are effec-

Table 1. Kinetic constants (*14*) of highly purified uricase (*8*) [0.01*M* tris(hydroxymethyl)aminomethane buffer at 20°C] and acid dissociation constants of binding sites on enzyme and enzyme-substrate complex.

Constant	Value
Kinetic constants	
$V'_{max} = k_3[E_t]$ (pH-independent maximal velocity)	1.7×10^{-3} μmole × min^{-1} × μg^{-1} of enzyme
k_3 (assuming a molecular weight of 100,000)	$1.7 \times 10^3 \times min^{-1}$
K_{ES} (pH-independent Michaelis constant)	$1.7 \times 10^{-5} M$
K_{SS} (excess substrate inhibitor dissociation constant)	$4.0 \times 10^{-4} M$
ΔE (activation energy)	1.24×10^4 cal × mole^{-1}
Acid dissociation constants	
pK_{aE}	7.5
pK_{bE}	9.2
pK_{aES}	7.2
pK_{bES}	9.5

Table 2. Enzyme-inhibitor dissociation constants for uricase-2,6,8 trisubstituted purine complexes (all in 0.01*M* tris-borate at pH 8.5).

Substituent in position			K_I (M)
2	6	8	
—Cl	—Cl	—Cl	8.0×10^{-7}
—Cl	—Cl	—OH	1.3×10^{-6}
—OH	—NH_2	—NH_2	1.8×10^{-6}
—OH	—OH	—H	1.2×10^{-5}
—OH	—OH	—OH	2.3×10^{-5}
—OH	—OH	—OH(urate)	2.5×10^{-5} (K_s at pH 8.5)
—Cl	—NH_2	—OH	4.0×10^{-5}
—OH	—NH_2	—OH	1.5×10^{-4}
—NH_2	—NH_2	—OH	5×10^{-4}
—NH_2	—OH	—NH_2	0
—NH_2	—NH_2	—NH_2	0

tive inhibitors for the enzyme (7). Williams has accounted for the great catalytic efficiency of cupric chelates on theoretical grounds (32). He postulates the *d*-orbitals of divalent metal ions as forming strong, continuous, overlapping molecular orbitals with the π- and σ-orbitals of certain ligands. We may extend this picture to include the substrate and acceptor in the present case. Electrons, either singly or in pairs, may then be capable of being transferred directly from the former to the latter. The metal is pictured as (i) providing a locus of physical attachment for both moieties of the catalytic complex, (ii) polarizing the electrons, to be transferred, away from the substrate by virtue of its strong electrophilic character, and (iii) permitting the actual interpenetrations of orbitals which we have alluded to. The somewhat greater liability to dissociation from the protein of the singly linked copper within the ternary complex may provide an explanation of two phenomena previously observed with other copper proteins—the exchange of radioactive copper with the copper of ascorbate oxidase, which occurs only in the presence of substrate and oxygen simultaneously (33), and the "reaction inactivation" common to many different cuproenzymes (28).

A somewhat similar picture has already been proposed to account for a large number of observations in the metalloflavoprotein series (34). Its possible extension to other metallodehydrogenases, such as other cuproenzymes and the zinc-pyridino-proteins, is now under investigation in this laboratory.

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Amedeo Avogadro

Two thousand years ago Lucretius in Rome expounded the doctrine of atoms. He expressed in immortal language the speculations of the Greek philosophers, and he described with the vividness of a great poet the movements, the unions and separations of the tiny corpuscles of which he conceived all things to be composed. The atoms had many qualities which modern science assumes even today. Vigorous motion under the appearance of rest, penetration of heat and cold depending on this movement, hooks for attachment to others, and even an unpredictable "clinamen" or swerve, which is a sort of fantastic anticipation of the uncertainty principle of quantum mechanics.

This was magnificent and represented a wonderful intuitive insight into the working of nature, but it was not science. There was no link with quantitative experimentation, the construction of which connection was lacking until modern times. Then, one might say suddenly, the science of chemistry was created by the vision of a few great men, among whom was Amedeo Avogadro.

The recognition by Avogadro of the distinction between atoms and molecules was the key which opened the treasury of structural chemistry: a treasury whose riches are not yet exhausted. The establishment of the true doctrine about the nature of the particles of the elementary gases rendered possible the development of the kinetic theory and the understanding of the energy relationships of these particles.

On this basis was founded the study not only of the structure of substances but of the functional relationships that govern chemical change: chemical kinetics. A true doctrine of molecules was the necessary precursor of what may

This article, by Cyril Hinshelwood, and the following one, by Linus Pauling, are based on addresses given in Rome on 6 June, when the Accademia Nazionale dei XL commemorated the centenary of the death of Avogadro. At the ceremony, a new medal, commemorating Avogadro, was presented by the Accademia, for the first time, to Sir Cyril and to Dr. Pauling.

truly be called both the anatomy and the physiology of chemical compounds.

There is irony in the fact that the importance of Avogadro's work was not understood for 40 years. This has of course happened to other men of science, and it should perhaps remind us that the advance of knowledge is in some measure an impersonal thing. However this may be, there is no doubt that one of the best ways of honoring the memory of the great scientists of the past is by considering the progress that has been made on the basis of their original labors.

In the century since the death of Amedeo Avogadro chemistry has undergone a marvelous transformation. Structural chemistry has now elucidated the architecture of substances the complexity of which would have seemed scarcely imaginable to the early chemists: the coloring matters of flowers, the proteins of animal and vegetable cells, constituents of all the varied and manifold products of nature. Perhaps the most remarkable advance of all is the synthesis of molecules to a defined purpose, as happens in the great industry of plastics, where molecules of enormous length rival or surpass both in size and in subtlety those of nature itself.

In this field of colloids one must of course incidentally allude to the wonderful result whereby molecules, consisting of so many thousands of atoms that they are actually visible in the ultramicroscope, obey the law of Avogadro—a principle upon which, as everyone knows, is based the determination of one of the most important of all physical constants, Avogadro number.

Today perhaps one of the greatest problems of structural chemistry is that of the nucleic acids, and of the wonderful relationships which exist between their configurations and those of the proteins, with which in the process of autosynthesis of living matter they are mysteriously and yet certainly linked. It was a long road from the simple diatomic molecules of hydrogen and oxygen to here.

Nevertheless, chemistry does not deal with static systems but with dynamic systems. Not only are the maps and plans showing how atoms are joined important, but also a knowledge of the forces which unite them and of the mode of operation of these forces.

By the time of Avogadro the valences of the chemist had not changed much from the hooks of Lucretius. Since his time, however, they have changed out of all recognition. The electrical theory of matter first revealed that the union of atoms is determined by electrons. (Indeed, it is upon the electronic charge and the value of the faraday that the best value of Avogadro's constant now depends.) The interpretation of the mode of action of electrons in effecting chemical union has led us very far from the simple realistic representations of Avogadro's day. This mode of action is understandable only in terms of quantum mechanics and the Pauli principle; and indeed in the last analysis there is nothing to explain the existence of the bonds between atoms except an abstract principle about the observability of particles. As the material victories of science multiply, the principles upon which our understanding of it is based seem to vanish into abstractions. Yet the work of Avogadro remains.

Structures and forces are still not the whole of chemistry. The processes by which atoms and molecules combine, separate, and rearrange themselves constitute a problem of fascinating diversity. Chemical kinetics is the vision of Lucretius, rendered precise and affrontable by experiment on the basis of the doctrine of Avogadro.

Chemical kinetics has itself evolved through the study of simple systems to the study of the formation of vast polymerized molecules, and from the study of isolated reactions to that of the complex mutually interdependent systems which determine the characteristic properties of the living cell. Some of these properties, such as adaptability, can be given an explanation in terms of chemical kinetics.

Perhaps, however, when we think of Avogadro it is to the simpler molecules that our attention should most be given, for, after all, a reaction system such as

$$H + H \rightleftharpoons H_2$$

is that which most readily comes to mind when his name is mentioned. It would hardly have been realized, however, in his time what intricate problems the kinetics of such reactions present.

The union of two atoms to form molecules requires, as is well known, the presence of a third body to remove the energy liberated.

$$H + H + M \rightarrow H_2 + M$$

But the efficiency with which the third body performs this function is very variable and is governed by factors only partially understood. By a thermodynamic necessity this efficiency parallels that with which the molecule M can transfer vibrational energy in a collision between H_2 and M. This in turn depends on the extent to which the proximity of M modifies the potential energy curve of the molecule H_2. Numerous studies of such transfers by indirect methods, including the study of supersonic dispersion and of photolysis by very intense, transitory illumination, have been made and continue to be made. A certain chemical affinity between the two colliding molecules favors the energy transfer; so also does the complete identity of the two molecules. In general, energy transfers between like molecules occur much more readily than those between unlike molecules, a fact for which the explanation must be sought, not in affinity, but in the exact fulfillment of quantum conditions.

The converse process—that is, the dissociation of a diatomic molecule—requires the correct energy transfer, after which the decomposition ensues at once. But even here there are complexities. The separated atoms may recombine, a process that is not at all likely in the gas phase but is more so in the liquid phase. As has recently been pointed out, the probability of the recombination—that is, the "reactivity" of the atoms—diminishes steadily to a limiting value during the time following their formation, as more and more inert molecules come between them. This fact is of some importance in the consideration of photochemical dissociations.

When the molecule becomes even a little more complex the problem of dissociation reactions becomes still more interesting. The energy required for dissociation—the so-called "activation energy"—must be communicated in a suitable collision. This process, as has already been explained, is one of considerable specificity. The energy then needs to be concentrated with sufficient intensity into the bond which has to be ruptured, for example, in the dissociation

$$N_2O \rightarrow N_2 + O$$

into the bond between N and O. The necessary redistribution of energy requires time. Thus, before it is accomplished the molecule may lose its energy in another collision. The result of this, as is well known, is that the first-order rate constant, k, of the unimolecular dissociation rises from zero at zero pressure to reach a limit k_∞ at high enough pressures. The value of k_∞ is often given nearly by

$$k_\infty = \nu e^{-E/RT}$$

where E is the activation energy and ν a vibration frequency. When this relationship is obeyed, the condition for dissociation is indeed the localization of the energy E in one bond. Sometimes, however, the factor multiplying the exponential term is much greater, showing that another, and possibly less mechanical, picture of the process must be adopted. The details of this picture are not yet quite clear.

The form of the curve showing k for a unimolecular reaction in the gas phase as a function of p, the pressure, has occasioned much discussion, in which theory has sometimes outrun experiment. It is curious that one feature of this curve has long escaped recognition. And yet I believe it to be of fundamental im-

portance and to have a relatively simple explanation.

Although the subject is a little specialized, I shall mention it now as part of this homage to Avogadro, because in honoring the great men of the past who have pursued truth, it is well, if possible and in however humble a manner, to bring something that is new, and what I shall describe does, after all, relate to a simple molecular phenomenon.

The phenomenon in question may be exemplified by measurements on the chemical reaction

$$N_2O \rightarrow N_2 + O$$

recently reinvestigated very thoroughly by Lindars, in my laboratory. Similar effects are observed in several other reactions.

The curves of k as a function of p_{N_2O}, the initial pressure of the nitrous oxide, or as a function of p_X, the pressure of an added foreign gas, do not in rising from zero to k_∞ follow the course predicted by the standard theories but follow a quite different course.

They show, in fact, a series of changes of slope, separated by regions of more nearly uniform slope. The curve of k against p_{N_2O} rises at first from the origin; it then bends in such a way as to suggest that will soon become horizontal. It does, however, nothing of the sort but continues upward until at a much higher pressure it again shows a diminution of slope.

To understand the explanation, first consider the classical case. This involves the processes

$$\text{Normal molecules} \underset{1'}{\overset{1}{\rightleftharpoons}} \text{activated molecules} \xrightarrow{2} \text{reaction products}$$

These are two extreme conditions. If 1 is rate-determining (at low pressure), k is proportional to p_{N_2O}. If 2 is rate-determining and 1 and 1′ are nearly in equilibrium, k reaches the steady value k_∞. The change in slope of the k, p_{N_2O} curve occurs where the one rate-determining process gives place to the other.

If, as occurs, there are several regions where the slope changes, there would seem to be more than one change in the nature of the process that determines the rate. What does this mean? If we have the sequence of processes

$$\text{Normal molecules} \underset{1'}{\overset{1}{\rightleftharpoons}} \text{energized molecules type 1} \underset{2'}{\overset{2}{\rightleftharpoons}} \text{energized molecules type 2} \xrightarrow{3} \text{products of reaction}$$

then the rate-determining process may be 1 or 2 or 3. If 1 and 1′, on the one hand, and 2 and 2′, on the other hand, are specifically influenced by the pressures, and if further the transformations 2 and 2′ may be either spontaneous or pressure-induced, then the form of the curves can be fully accounted for. The changes in slope, in fact, occur where one rate-determining process is replacing another.

What then is the nature of the transformation from the energized molecule of type 1 to that of type 2? With the N_2O molecule it is probably the passage from the singlet to the triplet state. The fact that the direct transition of N_2O into $N_2 + O$ would be a violation of a spectroscopic rule was long ago realized, but the application of this fact in explanation of the relationships between k and pressure was not recognized.

Since there can be several triplet states, there can be more than one extra "bend" in the k, p_{N_2O} curve, as indeed experiments at higher pressures show to exist.

Whether the explanation in terms of singlet-triplet transitions applies also in the other examples, such as the thermal decomposition of saturated hydrocarbons, is a very interesting question, the answer to which must be awaited.

Thus it can be said that the problems raised by the association of atoms into simple compound structures, the fundamental conception of Avogadro, still have their mystery. To adapt the old Latin saying: *ex chemia semper aliquid novi.*

For centuries atoms lay concealed behind the tenebrous theories of the alchemists; even after Dalton, the diatomic molecules of simple gases long went unrecognized. In more than a century of the atomic theory, D_2O existed undiscovered in ordinary water. The triplet states of some simple molecules have apparently been unacknowledged participants in their chemical transformations. And so it must go on. But no discovery will ever excel in simplicity and beauty that which was made by Amedeo Avogadro.

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Avogadro's work forms the basis of the whole of theoretical chemistry, and especially of the structure theory of chemistry. The first step in understanding the physical and chemical properties of substances in terms of their structure, the problem to which Avogadro was devoted throughout his life, is that of finding out how many atoms of different kinds are involved in the molecules or crystals of the substances. It was this problem, the discovery of the correct molecular formulas of substances, that was largely solved by Avogadro in his great paper of 1811 and the papers that he published during later years. Avogadro was the first man in the world to know that water is H_2O, composed of 2 atoms of hydrogen and 1 atom of oxygen; that hydrogen itself is H_2, and oxygen is O_2; that ammonia is NH_3; that ethane is C_2H_6; that camphor is $C_{10}H_{16}O$.

It was impossible for the idea that atoms are held together by chemical bonds to be developed and to be given adequate experimental support until the correct formulas had been discovered for a large number of substances. It was impossible for the idea of chemical valence to be developed until the correct formulas of molecules had been discovered.

Avogadro began to write the correct molecular formulas for gaseous substances in 1811. From that year on until about 1860, when his system of atomic weights and chemical formulas was finally adopted by chemists all over the world, Avogadro was always far ahead of any of his contemporaries. There was never a time, after 1811, when any other scientist proposed a system of atomic weights of elements that contained fewer errors than the system contemporaneously used by Avogadro.

His first paper on this subject was "Essai d'une manière de determiner les masses relatives des molécules élémentaires des corps, et les proportions selon lesquelles elles entrent dans ces combinaisons," published in the *Journal de physique, de chimie, d'histoire naturelle et des arts* [**73**, 58 (1811)]. In this paper (I shall use modern nomenclature in describing his results) he assigned the formulas H_2, O_2, N_2, and Cl_2 to these elementary gases, and the formulas H_2O, NH_3, CH_4, SO_3, SO_2, CO_2, CO, HCl, NO_2 to the corresponding compounds. He also discussed the atomic weights of some metals, but without success, in the absence of information about vapor densities.

In 1814, in a second paper in the same journal, he discussed H_2S, PH_3, F_2, HF, and a number of other substances, including boron trifluoride and silicon tetrafluoride.

He returned to the problem again in 1821, when he published his third paper "Nouvelles considérations sur la théorie des proportions déterminées dans les combinaisons, et sur la détermination des masses des molécules des corps," a paper of 162 pages published in the *Memorie della Reale Accademia delle Scienze di Torino.* In this paper he discussed, in an entirely correct manner, the gas densitics

of cyanogen, C_2N_2; hydrogen cyanide, HCN; cyanogen chloride, NCCl; phosgene, $COCl_2$; and a large number of other substances. In particular, he returned to the problem of the correct atomic weights of boron and silicon. He showed that boron compounds have formulas such as BF_3, B_2O_3, H_3BO_3, and that compounds of silicon have formulas such as SiF_4 and SiO_2. Berzelius had used the formulas BO_3 and SiO_3 for the oxides of these important elements, and in consequence all of the formulas written for the borates and silicates were wrong. During the same year Avogadro also published a significant paper on the composition of organic substances.

Avogadro's discoveries of the correct atomic weights and the correct molecular formulas of compounds might well have been adopted by chemists and physicists throughout the world shortly after the publication of his third and fourth papers on this question, in 1821. We may ask the question: Why was the acceptance of Avogadro's system delayed for nearly 40 years, until Gerhardt and Cannizzaro presented Avogadro's arguments again, in a forceful way?

If Avogadro's ideas had been accepted in 1821, the history of chemistry, and the history of the world too, would without doubt have been much different. I am sure that within a few years of using the correct molecular formulas some chemist would have introduced the idea of the chemical bond, some chemist would have recognized that carbon is quadrivalent, some chemist would have begun to write structural formulas for organic substances—that it would not have been left for Frankland, Kekulé, and Couper to do this in the years 1852 to 1855. With the development of structural chemistry at this early time, chemists would have been stimulated to carry on many original investigations, as they were in the years following 1855. Someone else than van't Hoff and LeBel would have discovered the tetrahedral arrangement in space of four single bonds formed by a carbon atom, someone else than Werner would have discovered the coordination polyhedra of inorganic complexes.

It cannot be contended that Avogadro's ideas were not clearly expressed in his 1811 paper and the later papers. His argument in these papers is presented in a straightforward and logical way. His ideas are clearly expressed.

The suggestion has been made that Avogadro was such a modest man that he did not think that it would be proper for him to strive to obtain the acceptance of his ideas by other scientists. I have formed the opinion, from reading his papers, that this suggestion is not correct. Avogadro may well have been a modest man; but he was not restrained by his modesty from making a vigorous attempt to convince his fellow-scientists about the correctness of his hypothesis and of the system of atomic weights and molecular formulas that he had built with its use. Every few years throughout his life he published a paper devoted wholly or in part to the discussion of this matter.

For example, in the third of his six long papers on atomic volumes, published in 1843, he begins with a statement that he had a long time ago (1811, 1814, 1821, 1824, and later years) presented arguments showing that equal volumes of gases of different substances, under the same conditions of temperature and pressure and sufficiently removed from their condensation temperatures, contain the same number of molecules. He goes on to say "Ce principe est aujourd'hui assez généralement admis, ou explicitement ou implicitement, par les physiciens and les chimistes." In 1838 he had published a very clear discussion of his hypothesis, in 38 pages, in his four-volume book on the physics of ponderable bodies. In 1840 he gave a discussion "Sul principio che volumi eguali di gas contengono egual numero di atomi." In 1849 he published in the *Archives des sciences physiques et naturelles* (Geneva) [**11**, 285] a note about atomic volumes in which he stated again that his postulate must be accepted, in order to explain the results about combining volumes obtained by Gay-Lussac, and that indeed the hypothesis had been accepted by all physicists and chemists who make application of the theory.

Perhaps Avogadro himself was in part responsible for the delay in the acceptance of his ideas. First, I think that Avogadro could not imagine how great the value of his discovery was. We now can see, in retrospect, that almost the whole of the development of the science of chemistry has followed from the acceptance of the correct atomic weights and the subsequent development of chemical structure theory. It would have been difficult, however, to have foretold the course of events. If Avogadro could have foreseen how important his hypothesis would be in the history of science he would, I am sure, have devoted himself wholeheartedly to this field of work, and to the effort to obtain general acceptance of his system. Instead, he made a vigorous effort to understand the densities of substances in the liquid and solid states of aggregation. His extensive work along these lines has turned out to have little value. This work is described in six papers, totalling 680 pages, published in the years between 1826 and 1852.

I should like to compare the argument used by Avogadro in the discussion of his hypothesis about gases and that used in his discussion of molecular volumes in solids. In his discussion of gases he pointed out that there are two alternative explanations of the Gay-Lussac law of combining volumes. The first is that equal volumes of gases of different substances under the same conditions contain the same number of molecules. The second is that equal volumes of gases of different substances contain numbers of molecules that are in the ratio of small whole numbers; that is, that some molecules occupy twice or three times as large a volume as others. Avogadro considered that it was unreasonable that molecules of different kinds should occupy different volumes that were nearly exactly in the ratios of small integers to one another, and that accordingly it was reasonable to accept the first explanation. This is Avogadro's hypothesis, which is, of course, now called Avogadro's law.

However, for a reason that is discussed in his papers but that is far from convincing, he adopted essentially the second alternative in treating the molecular volumes of solids.

It is evident that Avogadro was a man with an intense curiosity about nature. He believed that a scientist should try to *understand* the world, and should not be content to tabulate the results of experiments—that is, simply to *describe* the world. For example, in his paper of 1843 on molecular volumes he discusses the work of Hermann Kopp. Kopp had calculated the atomic volumes of the elements, by dividing the atomic weights (as given by Berzelius) by the densities of the solid or liquid substances. The values that he obtained, corrected to the system of atomic weights of Avogadro, differed widely from one element to another. Avogadro says that Kopp did not try to *explain* the fact that the atomic volumes of different elements are different. All of Avogadro's work was an effort to explain the world.

In his effort to obtain a systematization of the densities of solid and liquid substances he rejected the hypothesis that atoms of the elements have essentially constant volumes, so that the molecular volume of a condensed substance may be expressed as the sum of the atomic volumes. Instead, he made the hypothesis, obviously suggested by his hypothesis for gases, that all molecules of solid and liquid substances have essentially the same volume, but that some deviations are shown from the standard molecular volume, as determined by the nature of the molecules. In particular he attempted to correlate the molecular volumes of substances with their electronegativities.

The soundness of Avogadro's intuition is evident. There is no doubt that many of the properties of compound substances are determined by the difference in electronegativity of the elements composing the substances. The modern elec-

tronegativity scale of the elements was formulated from the heats of formation of compound substances in which the bonds are single bonds. Schomaker and Stevenson have pointed out that the interatomic distances of pairs of elements are determined to some extent by their difference in electronegativity. If Avogadro had accepted the idea that molecular volumes may be represented approximately as a sum of atomic volumes, he might well have used this starting point, and have introduced a refinement involving a correction determined by the electronegativities of the elements.

Instead, however, he preferred to make the postulate of a standard molecular volume. He soon found, of course, that the molecular volumes, as calculated by taking the molecular weights of substances in the gas phase and dividing them by the density in the liquid or solid state, showed great variations, and no correlation with electronegativity or electropositivity of the substances. He then made a decision that was unfortunate. He decided to assume that the molecules in solids or liquids either might be identical with the corresponding gas molecules or might be different in size: one-half as great, or one-quarter, or one-eighth, or perhaps twice as great, or three times. This assumption permitted him to introduce an arbitrary factor (a small integer or a simple fraction) for each substance. He introduced this factor in such a way as to obtain corrected molecular volumes that could be correlated with the electronegativities of the substances or with the heat capacities or some other physical property.

The degree of success achieved by Avogadro is indicated by the table in his 1843 paper. In this table values are given of the atomic volumes for 25 elements, in the solid or liquid state. The atomic volumes cover a range from 0.4 to 1.5, and the elements arranged in order of atomic volumes, as calculated by Avogadro, are also roughly in the order of their electronegativity, beginning with chlorine and ending with sodium. Avogadro obtained this correlation, however, by taking for chlorine an atomic weight one-quarter as great as that corresponding to the formula Cl_2 for the gas, and for other elements values one-quarter, one-half, or twice the standard atomic weights. For example, he obtained nearly the same atomic volumes for sodium and potassium, as solid substances, but only by the device of taking the atomic weight of potassium one-half as great as the correct atomic weight.

Why did this clear-headed, imaginative, and able scientist make this assumption, which seems to us to be unreasonable? I think that we must remember that chemical theory was in a confused state 130 years ago. The idea that atoms of different substances have different combining powers, valences, had not yet been formulated. The concept of valence involves the introduction of integers, one, two, three, four, five, six, describing a difference in behavior of different elements. An indication of valence was provided by the difference between the chemical equivalents of substances and their atomic weights. Small integers were involved in formulas such as H_2O, CO_2, NH_3. I think that Avogadro was searching for some way to introduce a new set of small integers into chemistry, and that he had the misfortune to select a wrong way of doing it.

Nevertheless, even though Avogadro's studies on molecular volumes, acidity and alkalinity, heat capacity, and other properties of substances were unsuccessful, he was attempting to follow a procedure that has been valuable throughout the development of chemistry, and that permitted him, in his formulation of his hypothesis for gases, to make one of the greatest contributions to chemistry that has ever been made. This is the procedure of formulating an imaginative, new principle, in the effort to bring the facts of chemistry, discovered by experiment and observation, into a system. The hypothesis that Avogadro made about molecular volumes of solids turned out to have no value. In fact, by suggesting that the molecules of a gas may split into smaller molecules when the substance condenses to a liquid or solid, Avogadro may well have helped to confuse his fellow-scientists about the significance and reality of the gas molecules, and have helped to postpone the general acceptance of his postulate about gases and his system of atomic weights and chemical formulas.

There seems to be no doubt about Avogadro's own convictions. Even in his papers on molecular volumes in solids he mentions from time to time the use of gas densities in order to determine the *correct* molecular formulas of substances, and he almost always uses, in these early papers, the formulas that are now accepted as the correct ones.

While reading the papers by Avogadro on molecular volumes of solids, I have been led to make a comparison between this unsuccessful effort by Avogadro to understand the properties of solid substances and my own effort, during the last 20 years, to understand the properties of metals and alloys. I ask that you allow me to refer briefly to this effort.

It is well known that, long after the structure theory of organic chemistry had been developed, beginning 100 years ago, and the structure theory of general inorganic chemistry had been developed, especially in the period around 50 years ago, no chemical theory of metals and alloys had yet been formulated. In 1938 I published a paper on the valences of metals and the structure of intermetallic compounds. In this paper and succeeding ones there has been described a chemical theory of metals and alloys.

One might say that chemistry has now been swallowed by the physicists, through the development of quantum mechanics. Dirac said, some time ago, that the Schrödinger equation encompasses the whole of chemistry. It is true that theoretical physicists have attempted to describe metals and alloys by use of approximate solutions of the Schrödinger wave equation. They have found, however, that the job of solving the Schrödinger equation for a metal or alloy is such a difficult one that it cannot be carried out with much accuracy, and I believe that there is still room in this field for the application of the old chemical procedure, that of attempting to obtain by induction, from a great mass of experimental facts, a simple empirical theory that compasses these facts. This is what Avogadro was trying to do in his discussion of the molecular volumes of solids.

In my discussion of metals and intermetallic compounds I was led to assign metallic valences to metals that seem strange. For example, iron, cobalt, and nickel were assigned the metallic valence 6, as were also chromium and manganese. The valence 6 for chromium is, of course, a reasonable one—this is one of the standard oxidation states of chromium. Also, 6 may not be unreasonable for manganese. But iron, cobalt, and nickel usually have smaller oxidation numbers in their compounds, and the valence 6 may be considered to be surprising.

Still more surprising is the result of the consideration of the properties of copper and zinc, as metals and in intermetallic compounds. Copper in its ordinary compounds is assigned the oxidation number +1 or +2, and zinc always has oxidation number +2. In metallic copper and metallic zinc the valences of these elements are indicated to be 5½ and 4½, respectively. Similarly gallium is assigned the metallic valence 3½, and tin, the congener of germanium, has the valence 2½ in the metallic form, white tin.

Moreover, in connection with these valences, the postulate was made, as an explanation of them, that there is one orbital, or, rather, three-quarters of an orbital, for each atom in a metal that serves some special purpose, and is not to be assigned electrons in the usual counting up of orbitals. This orbital is called the metallic orbital. That a metal must have about three-quarters of a metallic orbital per atom in order to have metallic properties is a pure postulate, indicated by some facts, by some properties of metals, but not derived from the Schrödinger equation or from any other theory. This postulate of the metallic

orbital may be compared with the postulate that Avogadro made, that the molecules in solids are one-quarter or one-half as big, or perhaps twice as big, as the molecules in gases. Avogadro was led to this incorrect postulate by the success of his gas-volume postulate. I have been led to apply ideas about valence to metals by the success of valence theory in organic chemistry and ordinary inorganic chemistry.

I do not know whether the system of metallic valences that I have formulated, and the postulate of the metallic orbital too, will have the same fate as Avogadro's assumption about molecular volumes of solids. Perhaps someone will think of a completely new way of handling the problem of the structure of metals and alloys. Perhaps the idea of valence should not be extended from the compounds of organic chemistry and ordinary inorganic chemistry to metals and intermetallic compounds. Nevertheless, I feel that there is still reason to attempt to apply the old methods of argument that have been used by chemists especially, including Avogadro, during the past 200 years, in an effort to discover laws of nature by induction from a great mass of experimental and observational information.

Avogadro was a great man. He was a thinker—a man who tried to understand the world.

Although he seems to have departed from the faith in being willing to split molecules in solids, I think that Avogadro really believed in molecules. In 1839 he gave a clear discussion of isomerism in terms of molecular structure. He described two isomers as substances which present different arrangements of the atoms out of which their molecules are formed. It is unfortunate that he was not led by considerations of this sort to ask what the forces are that hold the atoms together.

A description that he gave of a molecule in 1849 seems almost modern. He wrote: "It seems to me that one can think of the combination of several atoms of different kinds only as their union into a single molecule, in which one can no longer distinguish the parts of the volume that belong to the individual atoms. The atmospheres of imponderable bodies that surround the atoms in the separated state, and that hold them at a certain distance from one another, and thus determine the volume, should interpenetrate and become combined, in such a way as to form only a single atmosphere for the entire molecule, surrounding the individual atoms, and bringing them rather closer together than are the resultant molecules themselves, and thus determining the molecular volume of compounds." This sounds much like a modern description of a molecule, with imponderable bodies replaced by electron clouds.

I do not know whether Avogadro would be happy in the modern world, or unhappy. Chemists know too much now; perhaps we should say that physicists have discovered too much. It is hard for a chemist now to find a part of chemistry where hypotheses, chemical hypotheses, can be made. I almost feel that Schrödinger did the chemist a disservice when he developed the wave equation. But biology still offers a great opportunity for theoretical discovery, for the development of new hypotheses. Perhaps Avogadro, if he were living now, would be trying to think of a new Avogadro's hypothesis, a hypothesis relating to the gene, perhaps, to enzymes, to viruses, to the nature of life.

We are fortunate in having the example of Avogadro and the hypothesis that he made in 1811, to show us clearly how great is the value of hypothesis in science.

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A. J. Carlson

The death of A. J. Carlson on Sunday morning, 2 September 1956, in Chicago, was not a surprise to anyone who knew of his illness but was a shock to everyone acquainted with him. A man so strong in body and soul, so permanent in his influence, so timeless in his outlook, partook sufficiently of the stuff of immortality to seem to belie a vulnerability to disease and death.

Appropriate though the appellation "Ajax" may have seemed, I somehow never much fancied it. Perhaps it was because Homer's Ajax, the embodiment of strength and courage, was yet second to another—Achilles—in these attributes. Dr. Carlson had no Achilles. I preferred "Carlson," a common enough name but one encompassing all strength and courage, dignity and distinction. In any academic or scientific gathering, there was never any doubt about the identity of "Carlson."

Strong and *powerful* are words that belong to Dr. Carlson. His powerful physique supported an intensely active life of full 81 years. His sturdy integrity knew no compromise with the right and the good. His strong mind cut straight through to the truth. But with all his strength, he relentlessly fought the abuse of power. Tyranny was his enemy, whether it was economic or political, scientific or academic.

He lent his strength where it was needed. At whatever session of a scientific meeting one of his graduate students appeared on the program, Dr. Carlson was sure to be on hand, usually in the front row, to encourage and support. Woe betide the unfair critic who rose to an unwarranted attack upon the graduate student's paper.

Behind an austere or even forbidding aspect, Dr. Carlson was a staunch friend; he was loyal, warm, encouraging, inspiriting to his graduate students. His conscience about teaching was boundless, almost a religion. He wanted everyone to understand something about man's body in health and disease. Scores and hundreds of medical students remember Carlson as the greatest influence in their scientific experience. He was a superb teacher of college freshmen, whose instruction he was unwilling to relegate to junior staff members.

Unerringly, he could place a finger and say of a research project, a reasoned argument, a conclusion drawn, "thou ailest here, and here, and here." His penetrating incisiveness was liberally peppered with a ready wit.

His prodigious work-drive, guided by a disciplined intellect and fired with imagination, shed new light upon the operation of virtually every organ and system of the body. Nerve conduction, the heartbeat, digestion, hunger, thirst, thyroid function, diabetes, lymph formation, nutrition, the parathyroid glands, salivary secretion, and a score more, in

turn, captured his attention and yielded important secrets to his insistent probings. In his zealous pursuit of comparative physiology he scooped up every creature he could find in the Pacific Ocean for study and then repaired to the Atlantic Ocean for yet other organisms. The tremendous volume of research he stimulated in the many others who came under his influence is beyond estimation.

One modern concept of human life completely escaped his comprehension —retirement. For 16 years after he was labeled "emeritus" he continued unremittingly to fight against ignorance and superstition, disease and death—against quacks and quackery, alcoholism, antivivisection, and the processes of aging.

His beginnings were as humble as his full stature was lofty. A goatherd in the Sweden of his birth, he came to America at the age of 16, was a carpenter for a time, and then attended Augustana College at Rock Island, Illinois, where he received the B.A. and M.A. degrees. He chose a life of science, and took the Ph.D. degree at Stanford University in 1902. Two years later, he returned to the scene of earlier days, to take his place in the van of those scholars who have pronounced the "mighty learning" of the University of Chicago. Recognition of his quality as a scientist and his stature as a man of character and intellectual courage was widespread. This recognition was formally symbolized by numerous honorary degrees and by his election to the National Academy of Sciences and to the presidency of the American Association for the Advancement of Science.

I had the rare great privilege of knowing Dr. Carlson as a medical student in his classroom, quiz section, and laboratory, as a colleague in teaching, as a collaborator in research, as an associate in reporting investigation, as a coauthor upon many occasions, and as a companion in play. I knew him as well as any knowing can comprehend a powerful intellect, a sturdy soul, a great man. Yet, it was not necessary to know Carlson as well or as long as I did to know him a great deal. One encounter might suffice for a permanent impression, perhaps when Dr. Carlson arose to state: "Your research buildings and equipment are superb. Have you given as much thought to securing the brains to use them?"

Dr. Carlson loved a rough and tumble scientific scrap. He loved his work and his responsibilities, his family and his colleagues and his fellowman, his opportunities and his contributions. But, as his university's alma mater song tells, he could not have loved these so well, loved he not truth and honor more.

VICTOR JOHNSON
Mayo Foundation, University of Minnesota Graduate School, Rochester

T. Dantzig, Historian and Interpreter of Mathematics

Born in 1884 in Shavli, Russia, Tobias Dantzig took his licencie in Paris in 1909 and his doctorate in 1917 at the University of Indiana. While in Paris he studied under the great French masters of mathematics: Appel, Borel, Boussinesq, Darboux, Goursat, Hadamard, Picard, and Poincaré. From his stay in Paris he gained a conviction which he held throughout his life: mathematics should be acquired by study of the works of the masters. In pursuit of this belief his studies led him back through the medieval ages to the Greeks and their discoveries in science.

A lover of stories, Dantzig never forgot a tale. This vast reservoir was put to good use in the classroom, with more than one abstruse point in mathematics driven home with a salty epigram. He was intensely interested in mathematicians as people, and his writings are spiced with lively anecdotes surrounding the famous scientific personalities who captured his interest.

Dantzig's first book, *Number, the Language of Science*, broke a new path. This was the first attempt to bring mathematics to the layman in a manner calculated to capture the interest and enlarge the understanding. Starting with the rudimentary number sense displayed by birds and animals, he leads the reader by easy and gracious steps to some of the advanced outposts of mathematics. He was a great admirer of Poincaré and constantly sought to bring the genius of Poincaré within the ken of his audience. Although English was not his mother tongue, he displayed a phenomenal command of it in all his writing. This was not gained easily, however, for he wrote slowly, destroying more than he kept; on occasion, days would be spent before one or two lines reached the standard he set for himself.

After taking his doctorate and after a year each at Columbia and Johns Hopkins universities, he spent 6 years in industry bringing his mathematical training to bear on engineering problems. This acquaintance with industrial problems gave him a lifelong interest in the application of mathematics. He was one of a very few mathematicians who sought their livelihood outside academic circles 30 years ago.

Dantzig came to the University of Maryland in 1926 with promotion to full professor following in 1936. Two years later he became chairman of the department of mathematics. Under his leadership eager, young mathematicians were brought in, and mathematical research was added to the goals of the department.

After his retirement in 1946 he moved to the West Coast, seeking a climate more favorable to his health. In the 10 years that remained to him he taught courses in mathematics and in the history of mathematics, returning at times to mathematical consulting for industry and government.

His interest in the history of mathematics dominated him to the end, and his last work is entitled, *The Bequest of the Greeks*. His colorful personality made a deep impression on all who knew him, and he will long be remembered for his leadership and enthusiasm for mathematics.

MONROE H. MARTIN
University of Maryland, College Park

News of Science

Yerkes Laboratories

Operation of the Yerkes Laboratories of Primate Biology at Orange Park, Fla., has been transferred from Yale University to Emory University. Research will be continued under the auspices of Emory, with the same primary emphasis on the behavioral sciences. An international reputation has been built by the Yerkes Laboratories for studies of the chimpanzee growth and development, sex, and comparative psychology. The station's long-term scientific records are unique.

Investigations have shown that the chimpanzee most nearly approaches man in emotional responses. Because of the work at Orange Park, more is said to be known about the animal than is known about any other animal except the white rat.

Grants in support of continued research total almost $700,000, to be administered over periods varying from 1 year to 5 years. About $170,000 will be available for the coming year. Research is supported by the Ford, Rockefeller, and Carnegie foundations, the National Science Foundation, the Atomic Energy Commission, the National Research Council, and the National Institute of Mental Health.

The laboratories were established in New Haven in 1924 and moved to Florida in 1930. Yale is giving up the laboratories chiefly because of their distance from New Haven and of difficulties in coordinating the work of scientists in Orange Park with the organization of the Yale faculty. Emory was selected for the transfer because of its outstanding research programs in the basic sciences, biology, psychology, and other areas.

The 182-acre facility can accommodate 60 chimpanzees. Research at the laboratories has contributed to the development of the prefrontal lobotomy in treatment of insanity, and the Yerkes center was the home of the celebrated Viki, the subject of an experiment in rearing a chimpanzee in a human environment. Viki was raised in the home of a scientist. Other research has included investigations of sex behavior, learning, and effects of radiation. More than 400 research papers from study at the laboratories have been published in scientific journals.

Henry Nissen, director of the laboratories, will continue as director under the new sponsorship. The same board of scientific directors will continue to serve. It consists of Leonard Carmichael of the Smithsonian Institution, chairman, and George W. Corner, Rockefeller Institute of Medical Research; C. N. H. Long, former dean of the School of Medicine, Yale; J. Lawrence Pool, Columbia University; William H. Taliaferro, University of Chicago; Karl S. Lashley and Frederick L. Hisaw, Harvard University; and Nissen, ex-officio member. The laboratories are chartered as a nonprofit corporation under the Florida laws, and new officers of the corporation will be named later by the Emory board of trustees.

The late Prof. Robert M. Yerkes, a noted psychobiologist, started the unusual project in New Haven under the name, "Laboratories of Comparative Psychobiology." Need for a warmer climate for the animals resulted in the move to Orange Park, when the name was changed to "Yale Laboratories of Primate Biology." In 1942, one year after Yerkes retired, the name was changed to "Yerkes Laboratories" in his honor. Although the property was held by Yale, Harvard joined in operation of the center in 1942. Harvard's Dr. Lashley became director in 1942, and upon his retirement in 1955, Nissen was named to the post.

Paper Permanency: Labeled Sulfur Tests

It is well known that paper of good quality and high alpha cellulose content can be kept intact for several centuries. However, even good quality paper can become brittle at the edges. It has been pointed out that this may be because portions of the paper in old documents and books have been attacked by a strong acid. Since analysis of such old paper revealed a high sulfate content, it was assumed that sulfuric acid from the atmosphere was responsible for this deterioration. The concentration of sulfur dioxide in industrial atmospheres is of the order of 0.5 part per million; it is supposed that catalysts in paper accelerate the conversion of this sulfur dioxide to sulfuric acid.

By exposing paper under damp conditions to atmospheres containing about 0.5 percent sulfur dioxide, (10,000 times that of many industrial atmospheres), W. H. Langwell measured the increase in sulfur in the paper by extracting it with water and precipitating it as barium sulfate. F. L. Hudson and W. D. Milner have described a far more sensitive method, using sulfur-35 [*Nature* **179**, 590 (15 Sept. 1956)]. With their technique and under Langwell's experimental conditions, it was possible to detect the uptake of sulfur dioxide after a 2-hour exposure; after 24 hours it could be determined that the papers tested fell in general into the order already established by chemical means.

All papers were exposed to atmosphere before counting to allow gaseous sulfur dioxide to diffuse out. A steady counting rate was obtained after 4 hours.

Labeled paper samples, after exposure to sulfur dioxide under both wet and dry conditions, were placed between x-ray films for 3 weeks and then developed. The radioautographs showed some general uptake of sulfur, but they also showed random distribution of intense black spots with dark areas spreading from them. Next the paper was developed with acid potassium ferrocyanide, and it was found that the dark areas correspond to iron and in some cases to bronze spots in the paper. The take-up of sulfur dioxide is therefore partly general and partly localized.—K. L.-H.

National Library of Medicine

The Armed Forces Medical Library was transferred on 1 Oct. to the Public Health Service, Department of Health, Education, and Welfare. The National Library of Medicine Act, signed by President Eisenhower on 3 Aug., establishes a National Library of Medicine in the Public Health Service "to assist the advancement of medical and related sciences and to aid the dissemination and exchange of scientific and other information important to the progress of medicine and to public health." The Armed Forces Medical Library will form the nucleus of the National Library, which is to be headed by Col. Frank B. Rogers, director of the Armed Forces Medical Library.

The Armed Forces Medical Library was founded in 1836 as the Library of the Surgeon General's Office, U.S. Army. It contains almost a million volumes, representing literature on medicine, dentistry, pharmacy, and allied sciences in all languages and of all times. Its books

are loaned to other libraries throughout the United States.

In administering the National Library of Medicine, the Surgeon General of the Public Health Service will be assisted by a board of regents consisting of ten persons to be appointed by the President and confirmed by the Senate. Ex-officio members of the board will be the surgeons general of the Public Health Service, and the Army, Navy, and Air Force, the chief medical director of the Department of Medicine and Surgery of the Veterans Administration, the assistant director for biological and medical sciences of the National Science Foundation, and the Librarian of Congress.

The National Library of Medicine Act also authorizes the construction of adequate facilities to house the library on a site to be selected by the Surgeon General of the Public Health Service at the direction of the board of regents.

U.S.S.R. Opens New Research Center

The Joint Nuclear Research Institute that has been established by the Soviet Union and 11 satellite countries was officially opened at the end of last month. It is located in the small town of Pubna, U.S.S.R., approximately 95 miles northeast of Moscow. Institute officials estimate that the buildings and equipment cost about $125 million.

The purpose of the new center is to conduct high-energy research and to provide research facilities for training of nuclear physicists from all member states. In a press conference, Dmitri Blokhintsev stated: "There will be no secret work here. The results of all research done here will be published." Foreign correspondents from all over the world, including the United States, were taken on an extensive tour of the new institute. They were permitted to see all the important pieces of equipment and laboratories.

India Makes Penicillin

India's first penicillin plant, and in fact the first such plant in the whole of South Asia, was formally opened in August. The new $4-million facility, Hindustan Biotics, is in Pimpri, Bombay State. Seven factory buildings, some accessory structures, and a housing colony have been erected on a 200-acre site.

The World Health Organization assembled an international staff of construction engineers, chemical engineers, and medical officers who collaborated with Indian engineers on the plans. The United Nations Children's Fund which has supplied substantial amounts of penicillin to India, provided all the major items of machinery and equipment needed for the plant, at a cost of about $850,000. The expenses of land and building construction were borne by the Indian Government.

New Zealand Oil Search

More than $4 million is being spent by two groups of oil companies in a search for oil in commercial quantities in New Zealand. The British Petroleum Company has joined forces with another New Zealand company to carry out a search of the east coast, including offshore, extending over an area of 12,000 square miles. The two companies are spending an initial $1.4 million. At the same time, another joint company exploration, which calls for an expenditure of $2.8 million, is taking place on the west coast of North Island.

Several searches in the past have failed to uncover deposits in sufficient quantities to make recovery feasible. However, there are surface indications of the presence of oil in parts of New Zealand and, since New Zealand now imports all the oil the country uses—1.5 million tons of petroleum products last year—the discovery of oil would be of very great economic importance.

Molecular Chemistry of Mental Disease

The molecular chemistry of mental disease, a new area of research, is being investigated at California Institute of Technology under the direction of Linus Pauling. The program is underwritten by a $450,000 grant from the Ford Foundation, which will support the project for 5 years.

The research will be carried out largely in C.I.T.'s newly constructed Norman W. Church Laboratory for Chemical Biology. A part of the work will also be done in Pacific State Hospital of the California State Department of Mental Hygiene, with the collaboration of George Tarjan, superintendent and medical director of the hospital; Stanley Wright of the School of Medicine, University of California at Los Angeles; and Richard Morgan, statistical research officer of the State Department of Mental Hygiene. Pauling said last year when delivering the Edsel B. Ford lecture at the International Symposium on Enzymes:

"I forsee the day when many of the diseases that are caused by abnormal enzyme molecules will be treated by the use of artificial enzymes. When our understanding of enzyme activity becomes great enough, it may be possible, for example, to synthesize a catalyst for the oxidation of phenylalanine to tyrosine. A small amount of this catalyst could be attached to a framework inside a small open ended tube, which could be permanently placed within the artery of a newborn child who had been shown by chemical tests to have inherited the mental disease phenylketonuria. Through the action of the artificial enzyme, the child could then develop in a normal way."

In commenting on the probable course of the new research program at C.I.T. Pauling said: "We shall in general attempt to uncover basic principles rather than to attack specific practical problems. Nevertheless, it is expected that practical discoveries useful in specific fields may be made incidentally in the course of the fundamental investigations, and these discoveries are not to be ignored. Our major emphasis will be on basic research, but we hope to develop ideas that will provide the basis of clinical research on the medical problem of mental retardation."

Suicide in Denmark

An interesting comment on suicide in Denmark is contained in a letter from Milton I. Levine, M.D., that appeared in a recent issue of Ciba's *Medical News*. After describing Denmark's remarkable interest in pediatrics, Levine comments: "It is surprising that the suicide rate in Denmark is the highest in the world. According to WHO statistics, nearly one-fourth of all deaths among males are suicides in the 25–34 age group, while 13% of the deaths among females are suicides in the 15–19 age group. This fact seems almost incredible to anyone meeting these friendly people."

AEC Assistance for Foreign Reactors

The U.S. Atomic Energy Commission and the State Department are distributing to interested embassies and this country's industrial organizations the details of the program for U.S. grants of up to $350,000 for research reactor projects undertaken by friendly nations that have Agreements for Cooperation with the United States. The procedures are substantially those already used and tested in handling the first requests for assistance received following the offer made by President Eisenhower last year to strengthen the atomic research programs of those nations included in the bilateral agreement program.

As previously announced, grants of $350,000 each have been made to Brazil, Spain, Denmark, and the Netherlands. Negotiations for similar commitments are in progress with several other nations.

Congress appropriated $5.5 million for the program during the current fiscal year.

These grants may be used for financing an approved reactor project, providing the total of $350,000 is not more than one half of the actual cost. In addition to the reactor itself, a project may include experimental equipment, and supporting facilities and activities necessary to make it an operable and useful training and research facility. The grants are payable when the recipient nation certifies that the project has been completed.

Another International Conference on Atomic Energy

At the United Nations recently the Secretary-General's Advisory Committee on the Peaceful Uses of Atomic Energy discussed plans for another conference such as that held in Geneva in 1955. The committee recommended that this second conference meet on or about 1 Sept. 1958 for a 2-week period. The decision on the site of the conference will be made later.

In addition, the committee recommended that the conference, like the first one, be generally broad in scope and deal with technical aspects of the atomic energy field, particularly those related to nuclear power and the ecological problems it creates. Detailed plans for the 1958 program will be considered at a subsequent meeting of the seven-nation committee, which probably will be held in May 1957.

Secretary-General Dag Hammarskjold presided at the recent committee meeting, which was attended by the following delegates: Jayme de Barros and J. de Costa Ribeiro, Brazil; W. B. Lewis, Canada; Bertrand Goldschmidt, France; Homi J. Bhabha, India; John Cockcroft, United Kingdom; I. I. Rabi, United States; and V. S. Emelyanov, U.S.S.R. This advisory committee, which assisted in planning the 1955 international conference, was continued by the Tenth General Assembly when that body called for a second technical conference.

Latin American Agricultural Information

The Scientific Communications Service of the Inter-American Institute of Agricultural Sciences, Turrialba, Costa Rica, with the backing of the Rockefeller Foundation, has initiated an information project on current agricultural research for the benefit of Latin American research men. The technical editor of the Scientific Communications Service is Mario Gutiérrez Jiménez.

A central file has been established at Turrialba to record all current research work. Scientists in the various research centers in Latin America who wish to participate in this project should send information about their work to Turrialba in order to have it included in the central file. Later, progress reports should be submitted, and eventually, brief descriptions of final results.

The information that is received is condensed and distributed in leaflet form to participating institutions. Each of these participants receives a binder that permits the classification of leaflets by subject. The new publication series is named *Comunicaciones Científicas Agrícolas.*

In addition, a bimonthly news letter is issued. Also, lists of scientists, classified by fields of specialization, are distributed periodically in order to establish a catalogue of research workers. This is kept up-to-date and records the changes of personnel in each country.

In such manner, it is hoped that agriculturalists will be kept informed of the current events in agricultural research in the participating nations. Scientists have the benefit of rapid access to information about recent advances so that they may orient the research programs in their respective countries. Jiménez has toured a large part of Latin America and has found considerable interest among the research men who have been interviewed. The majority of the research centers visited are taking part in the program. The development of this information exchange was first suggested by a group of geneticists that met in São Paulo, Brazil, in 1952.

News Briefs

■ The U.S. Atomic Energy Commission recently conducted an 18-day tour of uranium deposits and ore processing facilities in the western United States for 36 foreign geologists and engineers. The group, which represented 22 nations, began the trip on 27 Sept. at Albuquerque, N.M.

The purpose of the tour was to acquaint the visitors with the various types of uranium deposits found in the United States and with applied exploration techniques, milling procedures, and laboratory methods. This dissemination of information is part of the program for international cooperation in uranium exploration that was announced by the commission on 8 Sept.

■ The East German Government announced on 25 Sept. that a group of German scientists and technicians had been repatriated to East Germany on 23 Sept. under a Soviet-East German agreement. This action was apparently the result of a recent note to the U.S.S.R. in which the West German Government charged that German scientists were being detained. The Bonn Government now reports that the East German regime is seeking to detain members of the group who wish to return to West Germany. The scientists, who were captured after World War II, include nuclear physicists and rocket specialists.

■ Thirteen more of the young Japanese women who came to this country for plastic surgery after having survived the Hiroshima explosion have returned home. Altogether, the 25 members of the group underwent 140 operations.

Scientists in the News

CARROLL V. NEWSOM, a mathematician, has been elected president of New York University. Newsom, executive vice president of the university since July, succeeds Henry T. Heald, who has become president of the Ford Foundation.

FRANK G. MILLER, formerly head of the systems engineering department in the Hughes Aircraft Company guided missile laboratories in Culver City, Calif., has been appointed head of the engineering laboratory of the company's guided missile laboratories in Tucson, Ariz.

VICTOR A. SUTTER, assistant director-general of advisory services for the World Health Organization, has resigned to accept appointment as minister of public health and social assistance in his own country, El Salvador. Sutter, who studied at San Salvador National University and Johns Hopkins University, has been a member of the WHO staff since 1950.

HENRY R. KREIDER, JR., former assistant director of research at William S. Merrell, Inc., Cincinnati, Ohio, has been appointed director of research at Chesebrough-Pond's, Inc., New York. He will coordinate the world-wide research facilities of the firm and direct development of new products.

EDWARD A. MARTELL, until recently research associate in radiochemistry at the Enrico Fermi Institute for Nuclear Studies, has joined the staff of the Air Force Cambridge Research Center, where he has been appointed chief of the atmospheric nuclear chemistry section of the Geophysics Research Directorate. Martell, a West Point graduate and former engineer officer, is a specialist in studies of the atmospheric distribution and fallout of atomic fission products.

SVEN SØYN, director of the Norwegian Geological Survey, recently visited the U.S. Geological Survey office in Washington, D.C.

BERNARD SALZBERG has been appointed chief scientist in the research and engineering division of the Airborne Instruments Laboratory, Mineola, N.Y. Salzberg, who for 15 years was a consultant and associate superintendent of the electronics division of the Naval Research Laboratory in Washington, D.C., is known for his work in the development of Acorn tubes, the first tubes ever designed capable of working at very high frequencies.

GEORGE F. LUNGER has resigned as senior analyst on the Ford Motor Company quality control staff to accept a position as mathematician in the advanced applications section of the Univac Division of the Sperry Rand Corporation, St. Paul, Minn.

HENRY K. BEECHER, Dorr professor of research and anesthesia at the Harvard Medical School, will deliver the 19th annual Louis Gross memorial lecture of the Montreal Clinical Society on 1 Nov. at the Jewish General Hospital, Montreal, Canada. He will discuss new work on pain and pain-relieving agents.

A. JAMES FRENCH has been appointed chairman of the department of pathology at the University of Michigan Medical School. He succeeds CARL WELLER, who retired on 1 July after having served as chairman of the department since 1931. French is professor of pathology and has been at the university since he completed a residency at the University Hospital in 1940. He is chief of Clinical Laboratories at University Hospital and editor of the *University of Michigan Medical Bulletin*.

Maj. Gen. EMERSON C. ITSCHNER has been sworn in as the Army's 40th chief of engineers. He succeeds Lieut. Gen. SAMUEL STURGIS, who is retiring.

J. MORLEY ENGLISH, associate professor of engineering at the University of California, Los Angeles, is on leave to organize Harvey Aluminum Structures, a division of the Harvey Machine Company, Inc., Torrance, Calif.

HARVARD L. HULL has been named vice president of Litton Industries, Beverly Hills, Calif. He resigned his post as president of the Farnsworth Electronics Company, a division of the International Telephone and Telegraph Corporation, on 30 Sept.

WARREN R. FERRIS, head of the radio astronomy branch at the Naval Research Laboratory, Washington, D.C., has resigned to accept appointment as professor of electrical engineering at the University of South Carolina. He is succeeded by EDWARD F. McCLAIN, who has been head of the microwave spectroscopy section of the NRL radio astronomy branch.

ARTHUR CODE, formerly an assistant professor of astronomy at the University of Wisconsin, has been appointed an associate professor at the California Institute of Technology. Another appointment to associate professor at C.I.T. is that of ROBERT FINN, who has been serving as an assistant professor of mathematics at the University of Southern California.

J. LOGAN IRVIN, associate professor of biochemistry at the University of North Carolina School of Medicine, has recently completed 9 months of research, supported by a Guggenheim fellowship, at the National Institutes of Health in Bethesda, Md., where he investigated the biosynthesis of proteins and nucleic acids.

FREDERICK SPERLING, pharmacologist-in-charge of the pharmacological and rodenticide laboratory of the pesticide regulation section of the U.S. Department of Agriculture, has resigned his position in order to establish the Sperling Laboratories in Arlington, Va., which will be devoted to toxicological, pharmacological, and physiological testing and research.

New appointments to the physics, mathematics, and engineering faculties of the University of Pennsylvania are as follows.

KEITH A. BRUECKNER of the Brookhaven National Laboratory, Mary Amanda Wood professor of physics.

HSUAN YEH of Johns Hopkins University, professor of mechanical engineering.

ORHAN H. ALISBAH of the University of Ankara, and PETER SCHERK of the University of Saskatchewan, visiting professors of mathematics.

LEE C. EAGLETON of the Rohm and Haas Company, and R. WAYNE HOUSTON of the University of New Hampshire, associate professors of chemical engineering.

NEV A. GOKCEN of the Michigan College of Mines and Technology, associate professor of metallurgical engineering.

DOUGLAS E. MODE of the Burroughs Corporation Research Laboratory, associate professor of electrical engineering.

WILLEM LASTHUYSEN, formerly chief chemist at Dodge and Olcott, Inc., has joined the perfumery and essential oils division of the research and development department of the Colgate-Palmolive Company, Jersey City, N.J.

WILLIAM E. FRYE, who has been engaged in aircraft navigation and ballistic missile guidance research for the Rand Corporation in Santa Monica, Calif., has joined the staff of the Lockheed Missile Systems Division research laboratories in Palo Alto, Calif.

RICHARD W. VILTER of the University of Cincinnati College of Medicine has been appointed to the Gordon and Helen Hughes Taylor professorship of medicine and director of the college's department of internal medicine. He succeeds MARION A. BLANKENHORN, who has retired after having held this dual post since 1935.

EDWARD WENK, JR., has been named chairman of the department of engineering mechanics at Southwest Research Institute, San Antonio, Tex. A specialist in stress analysis, naval architecture, and building design and construction, he was formerly head of the structures division at the David Taylor Model Basin, Washington, D.C.

Education

■ Fifteen industrial firms and government agencies have pledged a total of nearly $100,000 to Purdue University for a 3-year research program on extending the use and value of electronic computers. Basic research on computers from both the numerical and engineering standpoints will be performed within the program. Project director is Paul Brock, director of Purdue's computer laboratory. Engineering director is John R. Clark, associate professor of electrical engineering.

■ Checks totaling $515,000 have been mailed to 556 Merit Scholars and to the colleges they are attending. Sponsors for these freshmen are 23 business organizations and the National Merit Scholarship Corporation, which last season conducted the largest private scholarship competition in this country's history. Some 11,000 high schools entered nearly 60,000 of their best representatives in the competition, and winners come from every state.

Seniors at 13,000 high schools are expected to enter the 1957 competition. The first screening examination is on 24 Oct. Interested students should see their principals for details.

The nonprofit National Merit Scholarship Corporation was established in 1955

with initial grants that totaled $20.5 million. It is underwritten for a 10-year period. Besides providing some $2 million per year in scholarship awards, the Merit program is used by many companies who grant Merit Scholarships of their own.

The Merit Scholars are free to select any accredited college or university, and choose any course of study. Harvard is the most popular among the Merit Scholars, followed by Massachusetts Institute of Technology. Of this year's group, engineering and the physical science courses will claim 68 percent of the boys and 13 percent of the girls. Eighteen percent of the boys plan to major in physics, the most popular of the physical sciences. Of the 556 winners, 72 percent are boys and 28 percent girls.

■ An 8-week conference to improve the teaching of biology in high schools and colleges will be held at Michigan State University next summer. Twenty outstanding high-school biology teachers in the United States and 10 college and university biology professors will be invited to participate in the conference, which is being made possible through a $37,000 grant by the National Science Foundation. Chester A. Lawson, head of the department of natural science, will conduct the program.

During the summer, the teachers will attempt to develop a laboratory manual for use in high school—a manual of exercises that can be adapted to the needs of schools throughout the country. Two preliminary meetings to set up an outline for the summer will be held at Michigan State this year, with the first one scheduled for the Thanksgiving weekend.

■ In fulfillment of terms of a bequest of more than $9 million from the estate of the late Ralph Hochstetter of Buffalo, N.Y., four groups of postdoctoral research fellowships to be awarded to graduates of approved medical schools have been established at the University of Rochester School of Medicine and Dentistry. In his will Hochstetter, president of the Cliff Petroleum Company, provided that oil and gasoline royalties and other securities be divided equally between the medical schools of the University of Rochester and the University of Buffalo.

The new funds for Rochester make it possible for the school to conduct its research on a long-range basis. Much of the current medical research is financed by the government in the form of annual grants, which may be terminated at any time. The fellowships, to be named Bertha H. Buswell and Dr. Henry C. Buswell fellowships in memory of Hochstetter's late sister and her late husband, will permit recipients to pursue research in any of the several departments of the medical school. The awards have been divided into the following categories: Buswell junior fellowships, Buswell senior fellowships, Buswell faculty fellowships, and Buswell distinguished service fellowships.

■ A new division of sponsored research has been established at the Massachusetts Institute of Technology. It takes the place of both the division of industrial cooperation and the division of defense laboratories. Research at M.I.T. is largely sponsored either by private enterprise or by government agencies. Privately supported research and a substantial proportion of the Government sponsored research, other than the defense work performed for the Department of Defense, is an essential part of the educational program at M.I.T. and is conducted under the direction of the faculty in the campus laboratories. The administrative services for this work have in the past been provided by the division of industrial cooperation.

Research for the Department of Defense, on the other hand, is generally conducted in laboratories that are independent of the academic departments. Such work has been administered by the division of defense laboratories. Now, however, the new division of sponsored research has taken over policy guidance and general administration for both types of research.

F. Leroy Foster, who was director of the division of industrial cooperation, has been appointed director of the new division, and James M. West, an assistant in the division of defense laboratories, has been made associate director.

Henry W. Fitzpatrick, formerly director of the division of defense laboratories, has become assistant director for administration of the Lincoln Laboratory, the largest of the M.I.T. defense laboratories. Lawrence E. Beckley, who has been assistant director of the division of industrial cooperation, is now associate director for administration of the instrumentation laboratory.

■ A $440,000 physics lecture building is to be erected at Stanford University with funds provided by the university's royalties on the klystron. Construction will begin next month.

Grants, Fellowships, and Awards

■ The U.S. Public Health Service's National Institute of Neurological Diseases and Blindness has announced that funds are being made available to medical schools to strengthen existing clinical programs in advanced training in ophthalmological and otological diseases. The purpose is to stimulate the interest of more young physicians and scientists in careers as teachers and investigators in this field.

Training grants also are available to basic science departments to expand postdoctoral training programs in the neurological sciences. Further information, together with application forms, may be obtained from the Chief, Extramural Programs, National Institute of Neurological Diseases and Blindness, National Institutes of Health, Bethesda 14, Md.

■ The Engineering Foundation, New York, will be able to support an expanded research program with the income from a bequest for the benefit of the foundation to United Engineering Trustees, Inc., custodian of the foundation's funds. Some $425,000 is being made available from the estate of the late Edwin H. McHenry, civil engineer and railroad executive of Ardmore, Pa., who died in 1931.

In his will McHenry provided that upon the death of the last beneficiary his entire estate should go United Engineering Trustees, Inc., which is empowered to pay the net income from it to the Engineering Foundation for a period of 30 years. The will stipulates that the gift "constitute and be kept as a special trust fund for the furtherance of research in science and engineering" and that it be dedicated to the memory of his wife, Blanche H. McHenry. At the expiration of the 30-year period the principal of the fund held by United Engineering Trustees, Inc., may also be applied to Engineering Foundation research projects. At present the foundation administers the income from a $1.5 million fund dedicated to engineering research.

■ The Southern Fellowships Fund, acting for the Council of Southern Universities, Inc., and with funds granted to the council by the General Education Board, is offering a program of fellowship awards and grants-in-aid for advanced study and research to qualified persons in institutions of higher education in the following states: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. The primary purpose of the program is the advancement of teaching and scholarship in colleges and universities in the southern area.

Fellowship awards will be made for advanced study and research, leading to the Ph.D. or a similar high degree, primarily in the basic biological and physical sciences, the social sciences, or the humanities. Preference will be given to

applicants who expect to follow a career of teaching in colleges and universities in the South. Applications for 1957–58 must be submitted *by 15 Dec.* to the executive director of the fund, Robert M. Lester, 119 N. Columbia St., Box 427, Chapel Hill, N.C.

In addition, the Southern Fellowships Fund plans to continue its experimental program of limited grants-in-aid designed to assist faculty members now teaching in 4-year colleges to carry on advanced study or research during the summer of 1957. Application blanks will be sent only to those recommended by their colleges. Simultaneous applications for a summer grant-in-aid and a 1957–58 fellowship award will not be considered. Applications for a summer grant must be received by the executive director before *15 Feb. 1957.*

■ The Institute of International Education has announced that competitions for Government educational exchange grants for graduate study abroad will close *on 1 Nov.* The grants are made under the Fulbright and Buenos Aires Convention programs. Requests for application forms must be postmarked *by 25 Oct.* and completed forms must be submitted *by 1 Nov.* Scholarship application blanks and a booklet describing the overseas study awards are available at the institute headquarters at 1 E. 67 St., New York, and at its regional offices in Chicago, Denver, Houston, San Francisco, and Washington.

■ The most serious difficulty encountered by the Russell Sage Foundation in its work for more effective collaboration between the social sciences and the professional services is the scarcity of trained people. In order to help meet this shortage, the foundation offers postdoctoral residencies in operating agencies or professional schools for the purpose of providing qualified sociologists, social psychologists, and anthropologists with specialized training and experience relevant to professional practice in health or welfare.

Applicants are eligible for consideration for appointment (i) if they have received the doctorate or will have completed all requirements for the doctorate in sociology, social psychology, or anthropology before the date on which the requested residency is to begin; (ii) if they are not over 35 years of age; (iii) if they have records that clearly indicate superior ability; and (iv) if they are definitely interested in careers involving behavioral science and professional practice in either health or welfare.

Appointments are made for 1 year with the possibility of renewal for an additional year. Awards may be made at any time during the year. Stipends range from $3500 to $5000. For further information write to the Russell Sage Foundation, 505 Park Ave., New York 22, N.Y.

Miscellaneous

■ The U.S. Civil Service Commission has announced that applications are now being accepted for the following positions: public health biologist, medical entomologist, and chemist, and medical microbiologist in the fields of bacteriology, immunoserology, mycology, parasitology, and virology. The positions are in the Communicable Disease Center of the Public Health Service in Atlanta, Ga., and at other locations where the center's activities are conducted. The entrance salaries range from $5440 to $11,610 a year.

Full information and application forms may be obtained at many post offices throughout the country, or from the U.S. Civil Service Commission, Washington 25, D.C. Applications will be accepted by the Board of U.S. Civil Service Examiners, Communicable Disease Center, 50 7th St. NE, Atlanta 23, Ga., until further notice.

■ Throughout this month, the New York Academy of Medicine, New York, is exhibiting a collection of medical art that includes works by Rembrandt, Daumier, Hogarth, Toulouse-Lautrec, and other great masters. The collection, entitled *Ars Medica,* is owned by the Philadelphia Museum of Art, and is presented by Smith, Kline and French Laboratories, under whose grant the collection was assembled.

The scope of the show extends from medical illustrations designed for teaching purposes, such as those of Vesalius, Wechtlin, and others, to portrayals and critiques of medical procedures of the past. Assembled by Carl Zigrosser of the Philadelphia Museum, *Ars Medica* is the first collection of its kind. It is being displayed in 15 mobile units.

■ Opportunities for physical scientists and technicians exist in the Antarctic Program planned by the U.S. National Committee for the International Geophysical Year. A staff is being selected specifically to study the aurora and airglow.

Major geophysical research stations will be established at Little America, Marie Byrd Land, and the South Geographic Pole, and on the Knox Coast and along the Weddell Sea. Initiation of this program began last year with the site-reconnaissance voyage of the *U.S.S. Atka.* Operation Deepfreeze, now under way, will establish the Little America Station, cache supplies for the interior stations to be set up in the fall of 1956, and explore site possibilities for stations on the Knox Coast and the Weddell Sea.

The scientific program will cover 3 years, July 1956–July 1959. Scientists and technicians who have already been selected will leave the United States on about 1 Nov. 1956. Positions are now open for the period of investigations beginning approximately July 1957 and ending approximately July 1959. Prior to departure sometime in November 1957, advance training will be provided in problems of research, instrumentation, and operations in the polar regions.

Opportunities are available to candidates at the bachelor, master, and doctorate levels of training and experience. Scientists, engineers, and technicians, with training in physics, geophysics, astronomy, electronics, or closely allied areas are invited to address inquiries to Norman J. Oliver, Chief Scientist, Aurora and Airglow Program, c/o Geophysics Research Directorate, AF Cambridge Research Center, 415 Summer St., Boston 10, Mass.

■ Memorial services for Anton J. Carlson, world famous biological scientist of the University of Chicago who died on 2 Sept., will be held at 2 p.m. on 3 Nov. in the auditorium of Billings Hospital, 950 E. 59 St., Chicago. Lawrence A. Kimpton, chancellor of the University of Chicago; John O. Hutchens, professor and chairman of the department of physiology; and Lester R. Dragstedt, professor and chairman of the department of surgery, will be the speakers. Dragstedt, former pupil and longtime friend of Dr. Carlson, will deliver the principal address.

■ The International Commission on Zoological Nomenclature has announced that beginning on 28 Mar. 1957 it will start voting on the following cases involving the possible use of its plenary powers for the purposes specified against each case. Full details were published on 28 Sept. in the *Bulletin of Zoological Nomenclature* (Vol. 12, part 9): (i) Rafinesque, 1814–1818, names published by, for genera and species in the Orders Decapoda and Stomatopoda (Cl. Crustacea), suppression; (ii) *cruentatus* Linnaeus, 1758, *cubicus* Forskal, 1775, and *novemdecos* Sulzer, 1776, all published in combination with the generic name *Cancer* (Cl. Crustacea, Order Decapoda), suppression; (iii) URINATORIDAE Vieillot, 1818, suppression of, in favor of GAVIIDAE Coues, 1903 (Cl. Aves); (iv) *Peltura* (emend. of *Peltoura*) Milne Edwards (H.), 1840 (Cl. Trilobita), validation. Comments should be sent as soon as possible to Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1.

Reports

Isolation of the Infectious Bovine Rhinotracheitis Virus

During the fall of 1953 a disease characterized by sudden onset, pyrexia, abrupt cessation of milk flow, salivation, dyspnea, and severe inflammation of the upper respiratory passages and trachea was reported among dairy cattle in California (*1*). A clinically similar condition, although more severe, occurred among feedlot cattle in California in 1954 (*2*), and outbreaks have occurred intermittently since that time. Reports from Colorado indicated that a severe type of respiratory infection, clinically similar to that in California, had been prevalent there since 1951 among feedlot cattle and constituted a continuing problem for the cattle industry of that area (*3*).

The clinical syndrome could be reproduced regularly by the intranasal instillation of penicillin and streptomycin-treated nasal washings but not by the parenteral injection of blood, from early clinical cases. Calves that recovered from the experimental infection were immune to challenge with intranasal instillation of infectious nasal washings. Cross-protection tests showed that the clinical condition observed in California dairy and beef cattle and in Colorado beef cattle were the same disease. It was then recommended that the condition be designated as "infectious bovine rhinotracheitis" (IBR) (*4*).

Repeated attempts to recover an etiological agent in chick embryo, in weanling and suckling mice, and in guinea pigs were unsuccessful. These failures were followed by the successful isolation of the causative agent in tissue culture.

Tissue cultures of bovine embryonic kidney were prepared in tubes by a modification of the trypsin digest method of Youngner (*5*). Two nutrient media were used: (i) 0.5-percent solution of lactalbumin hydrolyzate in Hank's solution fortified with 6-percent lamb serum and (ii) mixture of 0.5-percent lactalbumin hydrolyzate in Earle's solution fortified with horse serum.

Nasal washings were obtained from calves that had been infected experimentally with nasal washings from naturally infected beef and dairy cattle in southern California and from beef cattle on Colorado feedlots. These washings, obtained in the acute phase of the disease, were treated with penicillin and streptomycin, diluted 1/10 with nutrient fluid, and inoculated into tubes of tissue culture. Cytopathogenic changes, characterized by rounding and shrinking of the cells and increased granularity and clumping, were seen in the tubes of beef embryo kidney 24 to 48 hours later. These changes continued through 96 hours until the majority of cells were affected, causing them to be released from the glass. Subpassages of infected tissue fluid regularly produced cytopathogenic changes in the tissue-culture cells of beef embryo kidney, testicle, and lung but never in HeLa cells, KB cells, L cells, or chick fibroblasts. A total of 37 serial transfers have been made in beef kidney with the Colorado isolate, and the cytopathogenic effect has occurred each time. Control material consisting of pooled nasal washings from normal animals produced no cytopathogenic effects, despite repeated serial passage. The virus has also been isolated from turbinate and tracheal scrapings and from the tissue of the larnyx but not from lung, liver, or spleen.

Titrations of the cytopathogenic agent have been made in tubes of embryonic bovine kidney cells by preparing decimal dilutions and inoculating 8 tubes per dilution. Replicate titrations show a $TCID_{50}$ of between $10^{5.5}$ and $10^{6.5}$/ml.

In two experiments cattle having no previous history of exposure to IBR were inoculated with infected tissue-culture material from the 4th, 7th, and 15th passages on bovine embryo kidney cells. The first experiment involved six calves inoculated intranasally with 4th-passage infectious or control tissue-culture fluid. Two animals were given California virus, two Colorado virus, and two normal nasal washings. The four animals that received the infected tissue-culture material developed pyrexia accompanied by nasal discharge, anorexia, dyspnea, and lassitude 3 to 5 days after inoculation—all characteristic signs of the illness described by McKercher *et al.* (*4*) and Jensen *et al.* (*6*) for the natural disease. The two animals given the control fluid showed no deviation from normal.

The second experiment involved two calves inoculated intranasally with infectious fluid from the 7th passage, and two with material from the 15th passage of the Colorado virus. Four additional calves were inoculated with the original nasal washings from which the tissue-culture virus was isolated. The clinical response of all of these animals was similar in every respect to that described for the animals in the first experiment.

Both preinfection and convalescent serums from experimentally and naturally infected cattle were tested for specific neutralizing antibodies against the isolates from both California beef and dairy cattle and Colorado beef cattle. Serial twofold dilutions of serum were mixed with approximately 1000 TC_{50} units of virus and held at room temperature for 2 hours. The mixtures were then inoculated into beef embryo kidney cell cultures, 8 tubes per dilution. In all cases a 1–10 dilution of convalescent serums from both naturally and experimentally infected cattle neutralized 1000 TC_{50} units of virus as indicated by the absence of cytopathogenic changes. The preinfection serums failed to prevent these changes.

There was no evidence to indicate that the virus isolates, of either source, were different antigenically. Convalescent California serum neutralized Colorado virus to the same degree as it did the homologous virus. These results are in keeping with those of cross-neutralization tests in cattle by McKercher *et al.* (*4*, *7*).

Attempts to incriminate other microorganisms as the potential etiological agent from both infected nasal washings and infected tissue-culture fluids have proved uniformly unsuccessful. The infected tissue-culture fluids used in these studies have been cultured and found to be bacteriologically sterile. In addition, a careful search of infected tissue-culture fluids has failed to reveal pleuropneumonialike organisms (PPLO) when cultured on standard PPLO media by the method of Adler *et al.* (*8*).

The etiological agent of IBR will pass through a fine sintered glass filter and will survive storage at −70°C for at least 7 months and at 37°C for at least 96 hours (*9*).

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7 May 1956

Identification of Protein Disulfide Reductase as a Cellular Division Enzyme in Yeasts

Previous work in this laboratory (*1*) has shown that divisionless mutant 806 of *Candida albicans* is genetically blocked at a reductive reaction in such a manner that metabolically generated hydrogen is "spilled over" in quantity, during growth, for nonspecific reductions. (Added dyes, and tetrazolium compounds, with redox potentials as low as $E_0' = -0.150$ v are readily reduced by growing cells of the mutant but not by the parent strain). This "waste" of reductive capacity by the mutant is not at the expense of demands of hydrogen acceptors participating in syntheses essential for growth, since mutant and normal strains synthesize cell mass at approximately the same rate; nor is it at the expense of respiration, since the mutant reduces oxygen even more rapidly than does the normal strain (*2*).

It is possible environmentally to induce filamentation and dye reduction in the normal strain by the incorporation of a powerful metal-chelating agent in the culture medium. Based on these facts, a biochemical lesion underlying the morphological alteration has been postulated to involve a flavoprotein locus, which has been converted to a diaphorase (causing nonspecific dye reductions) in the filamentous form, but which is presumably a metallo-flavoprotein in the normal strain and catalyzes the reduction of some hydrogen acceptor participating in cellular division.

The existence of a protein (containing 2.1 percent sulfur) bound to the mannan component of the cell wall of baker's yeast has recently been demonstrated (*3*). Enzymatic reduction of disulfide linkages in this protein was achieved by the use of cell-free particulate preparations from baker's yeast (*4*). Polysaccharide-protein complexes (containing about 2 percent sulfur) have also been found in the clean cell walls of both normal and filamentous strains of the yeast *C. albicans* (*5*). We wish to report that mitochondrial particulates obtained from the normal strain of *C. albicans* show powerful protein disulfide reductase activity on cell-wall protein, whereas similar preparations from the divisionless (filamentous) mutant possess such activity only to a very slight extent. The data presented in this paper permit identification of the "hydrogen acceptor participating in division" as the disulfide bond of the cell-wall mannan-protein component. Furthermore, the protein disulfide reductase that catalyzes this reduction may be termed a "division enzyme" and is the first such catalyst to be identified.

Normal strain 582 of *C. albicans* (ATCC No. 10261) and filamentous mutant strain 806 (ATCC No. 10259) were grown in a glucose, ammonium sulfate, biotin, salts medium with continuous agitation at 28°C for 48 hours. Batches of 20 lit were grown in 2-lit flasks (0.5 lit per flask) on a large reciprocating shaker to obtain sufficient cells for preparation of isolated clean cells walls by the methods previously described (*3*). Batches of 4 lit were grown in 250-ml flasks (100 ml per flask) on a rotatory shaker to obtain cells from which mitochondrial particulates were isolated, as was previously described (*4*). Mannan-protein was solubilized from isolated clean cell walls (*3*), and sulfhydryl groups of the protein were oxidized with ferricyanide. The resulting oxidized cell-wall protein was incubated with active or boiled mitochondria isolated from both strains of yeast (*4*). After incubation, the reaction mixture was centrifuged at high speed to remove particulates. The —SH content of the protein in solution was assayed spectrophotometrically by mercaptide formation with *p*-chloromercuribenzoate by the method of Boyer (*6*).

As is shown in Table 1, mitochondrial particulates isolated from the normal strain of *C. albicans* exhibit vigorous protein disulfide reductase activity against the cell-wall protein obtained from this strain and from the mutant. In contrast, the mutant exhibits only slight enzymatic reduction of —S—S— linkages of its own cell-wall protein. The relative activities, per unit density of mitochondrial suspension, for normal versus mutant strain were 24.4 to 1.0. Whereas mitochondria from the normal strain vigorously reduced disulfide of the mutant cell wall (7.3 times faster than the mutant itself), mitochondria from the mutant strain were completely lacking in ability to reduce —S—S— of the normal cell wall. Enzymatic reduction of disulfide covalent bonds in mannan-pseudokeratin, a major structural component of the cell wall of yeasts, is thus seen to be a reaction essential for cellular division of yeasts.

It is not possible here to consider the physical consequences of formation and breakage of covalent bonds between the molecular fibrils that make up the fabrics that constitute the cell wall of yeasts. However, it seems important to mention two aspects of this attempt to analyze the molecular bases of this area of cellular morphology. Examination of individual frames of time-lapse photographs (darkfield microscope) of budding yeast (*7*) reveals, in a most striking manner, that a bud-initial arises as a "blowout" from the mother cell. Localized enzymatic reduction of protein disulfide may operate at this stage of the division process to convert a portion of

Table 1. Protein disulfide reductase activity in normal and divisionless strains of *Candida albicans*.

Reaction system*	Mercaptide formation† (optical density at 255 mμ)	
	Enzyme system from normal yeast	*Enzyme system from divisionless mutant*
Oxidized cell-wall protein from normal yeast	1.156	1.156
Mitochondrial particulates	0.520 } 1.676	0.790 } 1.946
Cell-wall protein + particulates‡	3.800	1.880
Oxidized cell-wall protein from filamentous mutant	0.766	0.766
Mitochondrial particulates	0.520 } 1.286	0.790 } 1.556
Cell-wall protein + particulates‡	1.920	1.730

* The components indicated were added to the following basal mixture and incubated at 37°C for 2 hours: sodium succinate, 10 mg; ethanol, 4.5 mg; liver coenzyme concentrate (Armour) 50 μg; and 0.02*M* phosphate buffer, *p*H 7.0; reaction volume 3.5 ml. Where indicated, mannan-protein from 12 mg cell wall, solubilized as described (*3*), and 0.5 ml of mitochondrial particulate suspension (in 8.5 percent sucrose) were added.

† For determination of sulfhydryl content of protein, 2.0-ml samples were taken from the incubated mixtures and added to 1.0 ml of 0.3M acetate buffer, *p*H 4.6, and 0.5 ml 1.2×10^{-4}M *p*-chloromercuribenzoate (assayed spectrophotometrically at 234 mμ in 0.1M acetate buffer, *p*H 4.6, according to the method of Boyer, *6*). Mercaptide formation was allowed to proceed for 90 minutes at 37°C and then determined at 255 mμ.

‡ Values for controls using heated mitochondria were not greater than the sum of the constituents.

the "vulcanized" cross-linked wall fabric into a form capable of plastic deformation.

As is revealed by the electron microscope, polymer formation in the direction of growth develops as a densely intermeshed fibrillar network appropriate to an expanding prolate spheroid. It is important to note that covalent bonding between fibrils of the wall components that are not linearly ordered very likely serves to increase the modulus of elasticity in proportion to the number of covalent bonds (*8*). This feature of the wall fabric is undoubtedly essential for the expanding spheroid. The "ring type" of ordered fibrillar structure observed in "bud scars" serves to constrict the base of the bud in a plane normal to the direction of growth of the bud. This arrangement of fibrils is beautifully illustrated in electron microscope photographs of the yeast glucan layer by Houwink and Kreger (*9*). It is in the ordering of these fibrils that covalent bonding is believed to interfere. This may be a second stage in the division process during which maintenance of a sulfhydryl condition in a structural polymer is temporarily essential. Covalent (—S—S—) bonds might be formed, however, after the ordered arrangement has been achieved.

The molecular events in cellular division that have been uncovered thus far bring into fold many scattered, apparently unrelated, observations of the environmental control of cellular division. It is now intelligible, for example, that sulfhydryl substances applied externally to growing, but nondividing, cells might induce division in such cells (*10*). It is becoming increasingly clear that a cell possesses a variety of systems, each with its degree of specificity, for maintaining functional —SH groups. Those employed in growth may be operative while a disulfide reductase essential for division may have failed. In fact, this exact situation is met in the filamentous strain of *C. albicans,* which possesses both an active glutathione reductase and cystine reductase (*11*) but is deficient in a protein disulfide reductase.

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12 September 1956

"Permanent" Alteration of Behavior in Mice by Chemical and Psychological Means

We wish to report a behavioral response in mice which may be induced by both chemical and psychological means and which responds in some measure to drugs useful in mental illness. We had previously demonstrated (*1*) that fish exposed to LSD (lysergic acid diethylamide), upon return to a normal environment, exhibited an unusual and characteristic behavior pattern, and that this pattern could be rendered "permanent" by appropriate chemical treatment of the fish. In an attempt to extend this type of study to mice, we first searched for alterations in behavior that might be consistently attributed to treatment with LSD. We found that the behavior pattern described by Woolley (*2*) could be confirmed and that it was reasonably reproducible, but in the meantime Lars Flataker had pointed out to us a behavior response that was easier to determine.

The response consists of a rapid and violent head shaking when any area about the back of the head is touched very lightly with a small stick or pencil point. The head-twitch response does not occur in normal mice, and with a little experience the response is easy to detect. It is only rarely that one is uncertain whether a particular animal possesses the head twitch or not, and usually, if such an animal is followed, a clear-cut answer is found on the subsequent days. Independent observations by different workers are remarkably consistent, so that this provided a suitable tool for the behavioral studies.

If mice are injected intravenously with from 5 to 100 μg LSD (0.25 to 5 mg/kg), this characteristic head shake response appears in from 5 to 10 minutes and lasts for intervals of from 10 minutes to 2 hours, the length of time it persists being roughly proportional to the amount of LSD used. A variety of other substances (for example, mescaline, yohimbine, serotonin) do not elicit this response. The response is consistently reproducible in 90 to 100 percent of the animals injected and seems to occur in several strains of mice tested.

In an effort to render the head-twitch response "permanent," mice were injected intravenously with 30 μg indole (1.5 mg/kg), followed almost immediately by 30 μg LSD. All such mice showed the head-twitch response, but, in the majority of the cases, it subsided in 1 to 2 hours, and the mice were subsequently normal. However, in from 5 to 30 percent of the mice so treated (housed in groups of 10 each) the response remained for periods as long as a week, and in some cases for a few months. We have apparently therefore produced a "permanent" alteration in a particular aspect of mouse behavior by chemical treatment, in analogy to the alterations in fish (*1*), but such "chemical imprinting" is apparently more difficult in the mouse. Injection of either indole alone or saline produced no response, while injection of LSD alone produced only the usual temporary response.

It was also found that the identical response was produced in a larger percentage of mice by solitary confinement. The mice were placed in separate cages (one mouse to a cage) in which they had access to light, sound, and so forth, but were unable to see any other mice. Under these circumstances roughly 30 percent of the mice developed the head-shake response in 2 days (this percentage varied from 30 to 80 percent, depending on the strain of mouse employed). If such mice were kept in solitary confinement for 3 weeks (2 weeks is not adequate) and were then returned to groups (8 to 10 in a group), generally about 80 percent retained the response for weeks and even months. One has, under these circumstances, apparently rendered the response permanently "implanted." If such mice, in which the head-shake response has been permanently established, are treated with reserpine (5 mg/kg – p.o. for 3 days) about half become symptom free in 2 to 3 days and remain in this state as long as reserpine is supplied. When the reserpine is withdrawn, the head-shake response gradually reappears, even though the mice are kept in groups.

About another third of the mice do not develop the symptom until they have been kept in solitary confinement for at least a week. When these are grouped after 3 weeks of solitary confinement, the response is retained in most of the animals but is slowly lost with time. If such animals are given reserpine, most of them promptly lose the

head-shake response, and it does not return when the reserpine is withdrawn.

A third group does not develop the symptom on solitary confinement. This group generally consists of 30 to 40 percent of the population of most mouse strains that we have tried, but in some cases it is much less.

It appears from the foregoing, that a head-twitch response may be produced in mice by solitary confinement. This response is in all known respects identical to that produced by LSD injected intravenously. The response can be made "permanent" either by treating the mice with indole followed by LSD or by long exposure (3 weeks) to solitary confinement. When it is produced in a "permanent" fashion, the response may be temporarily relieved or may be cured by treatment with reserpine.

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8 September 1956

Distinction between Effects on Metabolic Transport and Passive Transfer of Ions

Studies showing that drugs, ions, metabolic inhibitors, and substrates induce or alter the net movement of sodium and potassium in nerve fibers have led to the recognition that such effects are brought about either by altering the metabolic reactions responsible for "active transport" or by modifying membrane permeability or the other electrochemical conditions for ion exchange and diffusion involved in "passive transfer" (*1–3*). A reliable method for distinguishing between effects on metabolism and on the passive properties of biological systems is increasingly necessary in the light of growing evidence for an intimate relationship between ionic movement and alterations in the physiological functioning of many cells (for example, *2, 4*).

It was previously found that while the net movements of ions are suggestive, they do not suffice as a definitive basis for such discrimination (*3*). On the other hand, research currently in progress with M. D. Berman on the unidirectional fluxes of ions in metabolically inhibited and uninhibited sciatic nerves of the toad (*5*) appears to provide one satisfactory approach to this problem. The purpose of this preliminary report is to provide two examples of the technique that demonstrate different types of results and to call attention to erroneous conclusions that may be drawn if metabolic and physical effects are not both considered as possibilities.

The approach consists of a comparison of the action of a given experimental agent or condition before and after metabolic inhibition on ionic flux. Anoxia combined with iodoacetate poisoning has been used as the standard procedure for inhibition because of evidence that this causes cessation of energy turnover (*6*). If, now, the result of treatment of an otherwise normal tissue duplicates that of metabolic inhibition, and this effect is absent when the tissue has been previously inhibited by anoxia and iodoacetate, then the original result is considered to be a consequence of interference with metabolic reactions. The effect of lowering the sodium content of the medium on potassium influx is in this category and is shown in Table 1.

The data in Table 1 were obtained by first exposing desheathed toad (*Bufo marinus*) sciatic nerves for 2 hours to normal or low-sodium Ringer's solution in the presence or absence of oxygen and 1 mmole/lit of sodium iodoacetate, then replacing these solutions for another 2 hours with similar solutions, except for the presence of K^{42}. Glass units identical with those previously described (*5*) assured good stirring and replacement of solutions without oxygen contamination when necessary. Conventional extraction and radioisotope-counting procedures served for measurement of the activity gained by individual nerves. The activity taken up, corrected for that in the extracellular space and for the small backflux, was converted to the equivalent uptake of potassium and divided by the time of exposure to K^{42} to give the influxes in Table 1 (and Table 2).

Our earlier studies demonstrated that metabolic inhibition depresses potassium influx in the desheathed toad sciatic nerve to one-third or one-fourth of that of controls (*5*). This can be verified in Table 1 by comparing the influx in oxygen with that in helium combined with iodoacetate treatment. In addition, Table 1 shows that reduction of the sodium content of the medium to 10 percent of the normal level under aerobic conditions also reduces the influx of potassium. This is true whether choline replaces sodium or whether sucrose replaces both sodium and chloride. The extent of the reduction of influx is about one-half as great as that produced by the combination of anaerobiosis and iodo-

Table 2. Potassium influx (μmole/g min) in paired desheathed toad sciatic nerves compared in Ringer's and in Ringer's with 0.1-percent cocaine with and without prior metabolic inhibition. As in Table 1.

Additional conditions	K^{42} exposure period	Control	Cocaine	Δ
O_2	2 hr	0.031 ± 0.0015	0.027 ± 0.0032	−0.0041 (6) ± 0.0025
O_2	4 hr	0.032 ± 0.0023	0.027 ± 0.0028	−0.0045 (6) ± 0.0028
He + IAA	2 hr	0.0113 ± 0.0005	0.0082 ± 0.0005	−0.0030 (8) ± 0.0004

Table 1. Potassium influx (μmole/g min), on a wet-weight basis, in desheathed toad sciatic nerves compared in Ringer's with normal sodium content and with 90 percent of the normal sodium replaced with choline or sucrose with or without metabolic inhibition. Δ is the mean difference with its standard error based on the differences of individual paired nerves on the same horizontal line. All variability is expressed as the standard error of the mean. The parenthesized figures give the number of experiments. The data in the last row are the only unpaired sets for Δ given to the right.

Other conditions	Choline chloride replacing sodium chloride			Sucrose replacing sodium chloride		
	100% Na	10% Na	Δ	100% Na	10% Na	Δ
O_2	0.042 ± 0.0019	0.030 ± 0.0022	−0.012 (16) ± 0.0024	0.048 ± 0.0019	0.034 ± 0.0021	−0.014 (6) ± 0.0022
He + 1 mmole/lit IAA	0.014 ± 0.0005	0.019 ± 0.001	+0.0054 (16) ± 0.0011	0.013 ± 0.0004	0.026 ± 0.001	+0.013 (4) ± 0.0008
		0.016 ± 0.0013			0.022 ± 0.0007	+0.0064 (4) ± 0.0018
		0.019 (20) ± 0.0011			0.024 (8) ± 0.0009	+0.005 ± 0.0014

acetate poisoning. But it is highly significant, as may be seen from the small standard error for the differences of paired nerves.

The reduction in aerobic influx in low sodium may therefore be the result of depressed oxygen consumption. Inhibition of respiration of nerve (7) by low sodium is known.

This interpretation gains further support from the absence of a decrease in potassium influx when the sodium is lowered while the nerves are being metabolically inhibited by the standard procedure. Indeed, the effect of decreasing sodium by 90 percent during inhibition is to produce a small but significant *increase* in potassium influx, which is slightly but significantly larger in sucrose than in choline.

The results in Table 1, therefore, lend themselves to the interpretation that a reduction of the sodium content of the medium reduces aerobic potassium influx by an inhibition of metabolism. In keeping with this, preliminary experiments have shown that under certain conditions potassium outflux can be increased by lowering sodium, as has also been found with metabolic inhibition (5). Since recent studies on the influence of external ion concentration on outflux assume that effects are due to the operation of ionic interchange, the present findings would suggest a careful evaluation of such interpretations. This is equally true for the effects of changes in the potassium content of the medium, since metabolic effects by the potassium ion are also well known.

The same approach to the action of a "stabilizer" such as cocaine presents an example of an effect on "passive" ionic transfer with little or no effect on active transport. Data demonstrating this are given in Table 2. Under conditions of metabolic inhibition, cocaine reduced potassium influx in each of eight paired preparations; the decrease is seen to be about 30 percent and is highly significant. Under normal aerobic conditions, whether measured over 2 or 4 hours, potassium influx is reduced by cocaine but proportionately much less; this decrease in influx in cocaine, although probably real, is on the borderline of significance. The absolute decrease in influx of the uninhibited nerves is of the same order as in inhibited preparations, as might be expected if the cocaine acts in the former on a passive influx that is of the same magnitude as the residual influx following inhibition. This is in keeping with other data, such as those in Table 1, which suggest that potassium influx in respiring nerves is the sum of a large metabolically dependent fraction and a small passive fraction (5).

The finding that cocaine does not markedly affect ionic transport through alteration of metabolic processes is consistent with the early demonstration of negligible respiratory effects by this and other "stabilizers" at blocking concentrations (8). It is also consistent with stabilizer action on the resting membrane potential being clearly demonstrable only under conditions of metabolic inhibition (9). The effect is probably on permeability, since other measurements demonstrate a comparable reduction of potassium outflux as well (5).

These experiments therefore appear to provide a valid means of discriminating between experimental effects by way of metabolic inhibition and through changes in permeability or other physical characteristics of living biological systems. It may be anticipated that both actions occur under some conditions.

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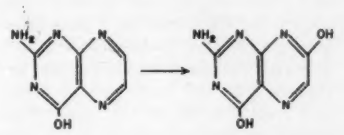
14 September 1956

Conversion of 2-Amino-4-Hydroxypteridine to Isoxanthopterin in D. Melanogaster

A number of pteridines occurring in Drosophila (1, 2) have been isolated and characterized, and their relation to one another and to the red eye pigments has been discussed (3). One method of establishing metabolic relationships among them would be to demonstrate interconversions in cell-free extracts. Since these compounds increase greatly in amount during pupal life (2), this stage of development was studied first.

Young pupae of *Drosophila melanogaster* (Canton-S wild type) were ground with sand in a chilled mortar with an equal weight of 0.1*M* potassium phosphate buffer, *p*H 7.5, and the resulting mixture was centrifuged at 100,000*g* for 30 minutes. To 0.1 ml of the supernatant solution were added 0.1 ml of buffer and 0.02 ml of a solution (1 mg/ml) of the pteridine under examination in water or 0.05*N* sodium hydroxide. An aliquot (about 4λ) of the mixture taken prior to and following an incubation period of 1 hour at 25°C was chromatographed on Whatman No. 1 filter paper for 2.5 hours in propanol-1-percent ammonia (2/1). After it had dried in air, the chromatogram was examined under ultraviolet light (Keese lamp; maximum radiation at 360 mμ) for the presence of fluorescent materials. No changes were observed when 2-amino-4-hydroxy-6-(1,2-dihydroxypropyl)-pteridine, 2-amino-4-hydroxy-6-carboxypteridine, or 2-amino-4-hydroxy-6-carboxy-7,8-dihydro-N^8-lactylpteridine was added to the extract. However, the enzymatic oxidation of 2-amino-4-hydroxypteridine to isoxanthopterin (2-amino-4, 7-dihydroxypteridine) was readily demonstrated.



2-AMINO-4-HYDROXY-PTERIDINE — ISOXANTHOPTERIN

In order to measure the rate of the reaction, the volume of the reaction mixture was increased in proportion to that described in the preceding paragraph, and 0.3-ml aliquots were deproteinized with 0.7 ml of 10-percent trichloroacetic acid (TCA). The amount of isoxanthopterin formed was measured by the increase in optical density at its absorption maximum, 340 mμ, using a Beckman model DU spectrophotometer. Treatment of the homogenate with charcoal (Norite-A), followed by a heat treatment of 10 minutes at 50°C, produced extracts with low blank readings, and these procedures were used to prepare the enzyme. Under the conditions described here, the enzyme was saturated with the substrate, and the rate of reaction was proportional to enzyme concentration. The *p*H optimum for the oxidation was about 7.5. Only a slight loss of activity was observed when the original extract was dialyzed; complete losses occurred when the extract was placed in a boiling water bath for 5 minutes. The enzyme is also present in larvae and adults.

This enzyme preparation from *Drosophila* pupae will also oxidize xanthopterin to leucopterin and xanthine to uric acid, all of these at approximately the same rate. It thus seemed likely that the activity was caused by xanthine oxidase, and, indeed, a preparation of this enzyme from fresh cream (4) oxidized 2-amino-4-hydroxypteridine to isoxanthopterin, and xanthine to uric acid, again at about the same rate. It has been reported (5) that 2-amino-4-hydroxy-

pteridine is oxidized by xanthine oxidase, although the product was not identified; and recently the production of isoxanthopterin by this reaction has been postulated to take place in the elytra of beetles, although no experimental details were given (*6*).

Since it is likely that a variation in the amount of isoxanthopterin would manifest itself during the synthesis of the eye pigments, 44 eye-color mutants of *Drosophila* (*7*) were tested qualitatively for the presence of the enzyme, in the following way. Larvae (15–20) which were just about to pupate were ground in a small test tube with a small amount of water (0.1 ml) and sand. 2-Amino-4-hydroxypteridine (0.02 ml of a solution of 1 mg/ml in 0.05*N* sodium hydroxide) was added, and aliquots were spotted on Whatman No. 1 filter paper immediately and at the end of 1 hour. The chromatogram was developed and examined in the same way as before. The great majority of the mutants had enzyme activity comparable to the wild-type controls. However, it appeared that maroonlike (*ma-l*) and maroon (*ma*) contained greatly reduced amounts of enzyme activity (*8*). Work is continuing on these phenomena.

There remains the question of the significance of this enzyme in the biosynthesis of pteridines. In order to show that the enzyme is active *in vivo*, white-apricot (w^a) larvae, which normally contain very small amounts of 2-amino-4-hydroxypteridine and isoxanthopterin (*2*, and unpublished data), were allowed to feed on powdered cellulose saturated with an aqueous solution of the former; after they had pupated, they were chromatographed according to the method of Hadorn and Mitchell (*2*). The chromatograms showed that 2-amino-4-hydroxypteridine had been ingested and that isoxanthopterin had been produced. It seems probable, therefore, that this enzyme is important in the biosynthesis of isoxanthopterin, and that 2-amino-4-hydroxypteridine is the immediate precursor.

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8. Since we submitted this paper, Hadorn and Schlink [*Nature* 177, 940 (1956)] have reported that the mutant rosy lacks isoxanthopterin. We have been able to show that this mutant also lacks xanthine oxidase. Further experiments in collaboration with Hadorn are in progress.

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13 June 1956

Modification of the Menstrual Cycle in Rhesus Monkeys by Reserpine

Reproductive function in the female rat is modified by reserpine. Gaunt *et al.* (*1*) found an alteration in the estrous cycle and a reduction in fertility. Barraclough (*2*) obtained inhibition of ovulation. Because of these observations, the possible influence of reserpine on the primate reproductive cycle was considered worthy of investigation. The dose used was in excess of that employed in clinical practice but was comparable to the dose used experimentally in rats and monkeys (*1*). Our purpose was to determine whether or not a maximal tranquilizing dose exerted a demonstrable effect on the menstrual cycle.

Adult, rhesus monkeys weighing between 4.4 and 8.6 kg were used. Three of the animals (909, 940, 921) had been pregnant, thus demonstrating their reproductive capacity. Reserpine (Serpasil, *3*) was administered subcutaneously to six monkeys in a dose of 1 mg/kg daily between 11 and 11:30 A.M. for periods ranging from 8 days to more than 100 days, Sundays excluded. The pattern of injection was of two types: (i) in some monkeys, daily injections of the drug were made for more than 100 days; (ii) in other monkeys, the drug was injected for a period of only 8 to 10 days, early in the cycle. Observations were made on (i) duration of the menstrual cycle, (ii) ovulation as ascertained by rectal palpation and checked by laparotomy, (iii) histological examination of ovarian and uterine tissues, and (iv) vaginal desquamation. Measurements of rectal, basal body temperature demonstrated no cyclic fluctuation. Three animals served as controls. Two of these animals later received a placebo, reserpine vehicle, in a volume equivalent to that which they would have received if the drug were being administered. Part of the remainder of the Carnegie colony served as additional controls with regard to length of the menstrual cycle.

Administration of reserpine daily for more than 100 days to three of the experimental monkeys produced a suppression of menstruation in each case (Fig. 1). In monkeys L52 and L53, in which the treatment was initiated toward the end of the summer anovulatory period, the expected bleeding occurred, but it was not followed by another menstruation until the drug was withdrawn. Laparotomy performed at the termination of the reserpine treatment revealed a failure of ovulation in each case (Fig. 1). Histological examination (*4*) in one monkey (L52) revealed a uterus under

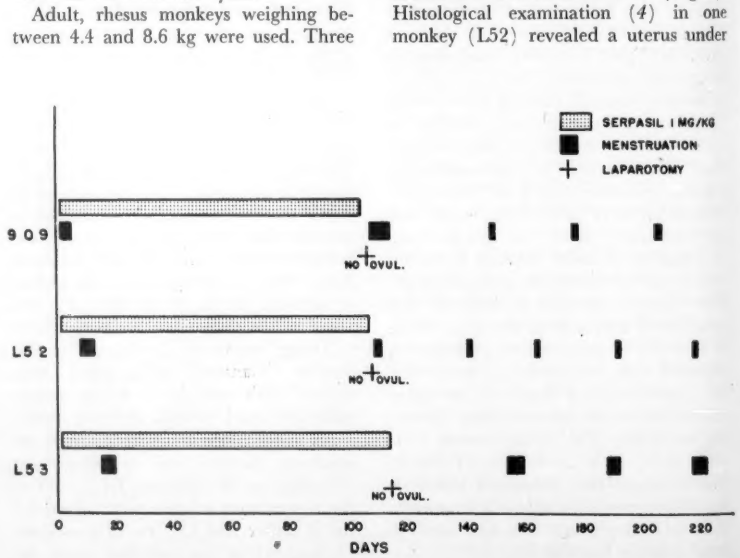

Fig. 1. Prolongation of the menstrual cycle following treatment with reserpine for more than 100 days. Width of the black bar indicates duration of bleeding.

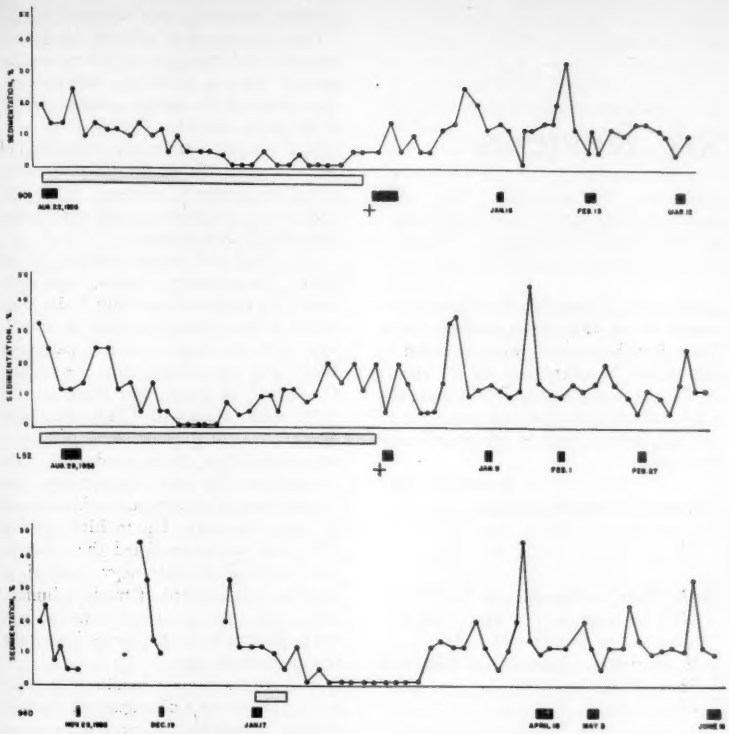

Fig. 2. Influence of reserpine on vaginal desquamation expressed as percent sedimentation (ordinates): (top curve) monkey 909; (middle curve) monkey L52; (bottom curve) monkey 940.

mild estrogenic stimulation. The left ovary showed only 13 growing follicles of 0.8 to 1.9 mm in diameter. Tissues from a second monkey (909) disclosed a thin (1.5 mm) endometrium that was involuted. This animal bled the day following biopsy. In the case in which no uterine biopsy was taken, L53 (Fig. 1), no bleeding was initiated.

Hartman (*5*) showed that a cyclic fluctuation occurred in the percentage of cellular desquamation obtained from daily vaginal lavage, with increased sedimentation on the days subsequent to ovulation. He found that vaginal desquamation in the presence of the "hypotypical" (Hartman) ovaries was zero. In the present experiments, Fig. 2 shows the effect of reserpine on vaginal desquamation. In animals 909 and L52, a low percentage in sedimentation was found during some part of the reserpine treatment. This depression was more prolonged in the case of 909 than in the case of L52 and correlated with the degree of uterine suppression noted for these animals at the time of laparotomy and biopsy.

Administration of reserpine for shorter intervals influenced the cycle, depending on the time of administration of the drug. A prolongation in the cycle occurred following treatment with reserpine from day 2 to day 12 (three cases) or day 2 to day 10 (one case). Laparotomy in two of these animals indicated that they had failed to ovulate by the 23rd day of their cycle. Vaginal desquamation was also influenced, monkey 940 (Fig. 2). Ovulation was not suppressed in two monkeys (data not shown) in which the drug was given from day 8 to day 16 of the cycle. No influence on menstruation was observed following administration of the placebo (vehicle) from day 2 onward.

In seven of the seven experiments in which reserpine was given during the early part of the menstrual cycle, menstruation was suppressed from 47 to 140 days, depending on the length of the treatment. These findings are significant especially when they are compared with the menstrual records of the remainder of the colony. In a total of 114 such cycles obtained from 26 animals between August 1955 and June 1956, 94 percent of the cycles were between 15 and 39 days in length, while only 6 percent were between 48 and 67 days. It is also significant that following withdrawal from this large dose of reserpine, menstrual cycles of normal duration were reestablished quite promptly (Fig. 1). Fluctuations in vaginal desquamation also showed periodic ovarian activity (Fig. 2). During drug treatment, the monkeys were poorly groomed in appearance, but they were able to maintain body weight and good fur growth developed during the winter.

We know of no report on the human being in which an alteration of the menstrual cycle has been produced with reserpine. This may be due to the fact that the clinical dose is usually smaller (0.25 to 5.0 mg/day orally), or that many recipients of the drug may have been in the menopausal or post-menopausal groups, and irregularity in menstrual periods is regarded as incidental and unimportant. Some evidence has been presented by Whitelaw (*6*) which indicates that chlorpromazine, another tranquilizing drug, will delay ovulation and menstruation in women for 8 to 16 days if the drug is given for 1 to 3 days before the expected date of ovulation. Barraclough (*7*) also noted that chlorpromazine blocked ovulation in the rat.

Plans are in progress to determine the minimal effective dose of reserpine in monkeys and the shortest duration of treatment necessary.

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22 August 1956

Book Reviews

The International Dictionary of Physics and Electronics. Walter C. Michels, Senior Ed. Van Nostrand, Princeton, N.J.; Macmillan, London, 1956. 1004 pp. Illus. $20.

It would be of some interest to know who conceived the idea of a voluminous reference document containing definitions—some long, some short—of most of the specialized terms encountered today in the literature of physics and electronics. The originator of the project and all those who had a hand in preparing this extensive one-volume compendium of useful information deserve the thanks of the scientific community.

Compilations of definitions of physical terms have been published before, but a brief search has failed to reveal any volume comparable with the *International Dictionary of Physics and Electronics.* In this work, the editor and the contributors have attempted to provide a reference tool useful (as the preface puts it) to ". . . the greatest possible number of those people who are working with physics. This group includes not only professional physicists, and those intending to make physics their profession, but also the far greater number of workers in other fields who have frequent need for information about terms used in physics."

Among the definitions in this dictionary one finds a variety of treatments of terms related to laws, relationships, equations, basic principles, instruments, and apparatus. Where a brief definition suffices, it is used: "DEKAGRAM. Ten grams." On the other hand, the editor has not made a fetish of brevity; the "definition" of "RELATIVITY THEORY, SPECIAL" occupies a full page, and more than three pages are devoted to the term "TELEVISION."

Several hundred line drawings (including a number of circuit diagrams) add to the clarity and completeness of the volume. The aim of the volume's compilers was the inclusion of "both formal and discursive statements and entries" in most definitions. This policy has necessarily resulted in a lengthening of the book, but the consequent gain in utility will probably justify the decision to present the material in this way.

Walter Michels, as senior editor, was assisted by 14 contributing editors representative of various specialized fields. Four British scientists were included in this group. The *International Dictionary of Physics and Electronics* will undoubtedly make a well-deserved place for itself in a large number of laboratories and libraries.

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E. A. Birge, a Memoir. G. C. Sellery. With an appraisal of Birge the limnologist, *An Explorer of Lakes,* by C. H. Mortimer. University of Wisconsin Press, Madison, 1956. 221 pp. Illus. + plates. $3.50.

In these days of ultimate specialization, it is both refreshing and encouraging to read about a scientist whose long life (just short of a century) encompassed notable careers in biology and administration, both of which were further enriched by remarkable talents in philosophy and religion and as an essayist and lecturer. This portrait of the life and accomplishments of Edward Asahel Birge is written by G. C. Sellery, his long-time friend and colleague at the University of Wisconsin. Sellery has drawn upon rich source material and abundant anecdote for his memoir on the many-faceted Birge.

The book contains seven chapters. "The preparation" and "The professor" cover his early life, education, and teaching. Professors and administrators will find that Birge as "The lieutenant of presidents" and "The president" (of the University of Wisconsin) had to deal with university problems and internal politics which have shown no fundamental changes in America during the past half-century. He was largely responsible for the development of the present stature of the University of Wisconsin.

As "The lecturer and essayist," Birge exhibited a broad knowledge of classical literature; he also had the happy ability of being able to write and speak for a wide variety of audiences on topics ranging from a popular lecture on Darwinism, limnology, or "culture" to an appeal to the state legislature or a masterly funeral memorial to a deceased friend. "The religious man" reveals his knowledge of the Scriptures and his reconciliation of science, evolution, and religion. His series of 13 annual sermons on St. Paul were models. "Some final estimates" contains an unusual evaluation of an alternate side of Birge's personality —his brusqueness, aversion to "small talk," rare indignation, and early criticisms of applied science.

The final and longest section of the book, "An explorer of lakes," was written by the English limnologist C. H. Mortimer. It is a general account of limnology, with the major classical papers of Birge and his collaborators (especially C. Juday) in mind. His most notable publications dealt with Cladoceran biology, diurnal migrations of zooplankters, annual plankton cycles, food webs, light penetration into lakes, temperature conditions, dissolved gases, and other aspects of lake chemistry. Up to his death in 1950, this work paralleled the development of modern limnology. Indeed, it *was* the development of modern limnology. And most of these contributions were published when Birge had gone beyond middle age!

In short, this book is an unusually penetrating picture of a distinguished teacher, scholar, administrator, and scientist—a fellow in a "race of giants." It should interest limnologists, nonscientists, and university administrators; it should appeal to those who knew Birge only slightly as well as those who knew him well.

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Weather Analysis and Forecasting. vol. I, *Motion and Motion Systems.* Sverre Petterssen. McGraw-Hill, New York, ed. 2, 1956. 428 pp. Illus. $8.50.

Weather Analysis and Forecasting. vol. II, *Weather and Weather Systems.* Sverre Petterssen. McGraw-Hill, New York, ed. 2, 1956. 266 pp. Illus. $6.

The second edition of Petterssen's well-known textbook is really an entirely new book. The revisions have been so extensive that almost nothing remains of the original edition. The orientation, material, illustrations, and organization, as well as basic concepts, have been completely altered and modernized.

The changes in the book reflect the transformation that meteorology has undergone in the last 15 years. In 1940, when the first edition was published, weather forecasting was a highly personal and subjective art with virtually no quantitative methodology. The basic ideas of synoptic meteorology found in the

first edition were the air mass and frontal concepts of the Scandinavian school. Almost the only quantitative procedures were Petterssen's kinematic formulas, which were never very powerful tools.

The transformation of synoptic meteorology began (about the time the first edition was published) with Rossby's vigorous applications of dynamic meteorology to weather forecasting. The vorticity concept became a central idea of synoptic meteorology, culminating in Charney's development of numerical weather prediction, the computation of prognostic weather maps by means of high-speed computers. At the same time the expansion of networks of upper air observations during and after World War II eliminated the need for inference about the structure of weather systems, providing weather analysts with a tremendous body of new data which forced them to revise their ideas and techniques.

In addition to numerical weather prediction, the last 15 years have seen the development of other quantitative forecasting procedures of a statistical nature. Graphical and numerical techniques of forecasting have been developed. The latter have been facilitated by the use of electronic data-processing machines which make it possible to digest the mountain of meteorological data required to deduce statistically useful relationships.

The meteorological revolution has not yet reached weather forecasting at the "will it rain today?" level, and the public may question whether forecasts are better today than they were 15 years ago. But the impact of these technologic developments on the thinking of synoptic meteorologists is evident in Petterssen's new book. The distinction between dynamic (theoretical) and synoptic (applied) meteorology is being erased. Thus the author lays down a sufficient groundwork of dynamic meteorology in this book to justify its use as an introductory textbook in dynamic meteorology.

The book is published in two volumes. (I question the necessity for two volumes, which is both inconvenient and expensive.) The first volume is devoted to applied hydrodynamics and the prediction of pressure and wind systems. Applied thermodynamics and the prediction of weather is left to the second volume. In both volumes the treatment is thoroughly up to date, and the book abounds in examples and references from the last 5 years. The relatively small size of volume II and the brief portion of that volume devoted to *weather* forecasting (as opposed to pressure forecasting) is representative of the currently lopsided state of development of synoptic meteorology.

A few errors are found in the book. The European, rather than the American, definition of sleet has been retained in the new edition. The definition of balanced motion on page 57 is incomplete, no mention being made of a balance of forces at right angles to the motion. The definition of relative humidity adopted by the International Meteorological Organization in 1947 is omitted in favor of the older definition. An unfortunate omission is that of the integrated baroclinic (for example, thermotropic) models from the chapter on numerical prediction.

The author deserves high praise for accomplishing the formidable task of bringing synoptic meteorology up to date.

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Polysaccharides in Biology. Transactions of the first conference, 27–29 April 1955, Princeton, N.J. Georg F. Springer, Ed. Josiah Macy, Jr., Foundation, New York, 1956. 271 pp. Illus. $5.

This book seems to be a verbatim transcription of a very informal conference. The table of contents looks interesting: "Problems of communication: nomenclature," M. L. Wolfrom; "Problems of classification," K. Meyer; "Bacterial polysaccharides," M. Heidelberger; and "Blood group substances," W. T. J. Morgan. Unfortunately the formal presentations are so frequently interrupted by questions and comments from the participants that it is very difficult to extract any useful information from the text. The comments are often amusing, if one has a taste for the macabre in science, and the book will make an interesting souvenir for the participants in the conference. This hardly seems justification for publishing such a book, and there is no excuse for selling it at $5.

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Bibliography of Solid Adsorbents, 1943–1953. An annotative bibliographical survey. NBS Circular 566. Victor R. Deitz. National Bureau of Standards, Washington, D.C., 1956 (order from Superintendent of Documents, GPO, Washington 25). iv + 1528 pp. $8.75.

V. R. Deitz and his collaborators at the National Bureau of Standards are to be commended for continuing to assemble the material that is published in this second volume in the series. The first volume covered the period 1900–42, whereas this one includes only the decade 1943–53. In spite of this shorter time period, the present volume cites twice as many publications as were listed for the previous four decades. However, the coverage is still restricted to heterogeneous phenomena at solid-liquid and solid-gas interfaces. Each entry is followed by a good abstract that has been prepared from the various abstract journals published here and abroad.

The authors list the references under seven chapter headings. Each chapter has a number of subsections. The first two chapters cover adsorption of gases and vapors and adsorption from solution, both on solid adsorbents. This material is followed by chapters on thermal effects and theories of adsorption. Chapter V is devoted to the refining of sugars and other applications of adsorbents. The last two chapters concern themselves with general information on adsorbents and special methods of investigation, together with the preparation of adsorbents. These are followed by a complete index of authors and subjects.

This reference volume does not claim to be complete, but the authors have not missed many publications. Workers in the field will find this volume more than useful, and younger investigators will be not only helped but stimulated by the thorough coverage of the important areas of solid-adsorbent research.

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Creatures of the Deep Sea. Klaus Günther and Kurt Deckert. Translated by E. W. Dickes. Scribner, New York, 1956. 222 pp. Illus. $3.95.

In general coverage of its subject, this is a thoroughly satisfactory volume, presenting an accurate, semipopular, overall picture and digested account of the known inhabitants of the deep sea. The scope of treatment may be judged by some of the chapter headings: "The poverty, sameness, extent, and inhabited regions of the deep sea," "Food of its fauna," "Inorganic foodstuffs," "Animal world of the ocean floor," and "Pelagic fauna and migration." The two most significant chapters deal with the biological peculiarities, distribution, and origin of deep-sea creatures.

To show one point of view of the authors, I quote a paragraph from one of the latter chapters.

"More general, though less striking at first, are the physical adaptations and peculiarities imposed on deep-sea animals by the other special features of their gloomy environment, the increasing cold in the depths, the relative stillness of the water, and the lack of calcium, especially

in the great depths. In all cases of such special features acquired by animals to enable them to cope with the special circumstances of their environment, in this case the deep sea, we speak of adaptation of the animals to their environment. It is better, however, not to associate with this conception the ideas of necessity and of the appropriateness of such adaptations, as was done in the past, for, as we have said, many animals manage without such adaptations, and of two closely allied species of the same genus, both living in the same way, in one the adaptations may be well developed and in the other entirely absent. Thus these adaptations are often not necessary changes, but merely changes made possible by the ecological system of the species or family concerned, changes which at a more advanced stage of development of the species or family may become biologically important and have an influence on natural selection."

The style of writing is excellent in spite of the difficulties of translation from the German. The illustrations are numerous and adequate, including both borrowed, adapted, and original ones. There is, unfortunately, no list of illustrations, nor is there any mention of them in the brief index. Since the book was originally published in 1950, there is understandably no mention of recent notable dives such as those of Piccard, Cousteau, and others. These recent dives have been characterized, however, by depth records rather than by additions to the sum of scientific knowledge. Clarity and compactness are the major advantages of the present volume.

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Advances in Enzymology and Related Subjects of Biochemistry. vol. 17. F. F. Nord, Ed., Interscience, New York, 1956. 556 pp. Illus. $11.

This annual publication needs no introduction to biochemists, and laudatory comments are superfluous. For certain of the chapters a listing of the title and author is sufficient indication of subject matter and quality. Such chapters are "Enzyme kinetics" by R. A. Alberty; "The respiratory chain and oxidative phosphorylation" by Britton Chance and G. R. Williams; "Enzymatic phosphate transfer" by Bernard Axelrod; "Formation of oligosaccharides by enzymic transglycosylation" by Jeffrey Edelman; "Nature and function of metalloflavoproteins" by H. R. Mahler; and "Chemistry and biochemistry of xanthine oxidase" by E. C. De Renzo.

"Solubilization, migration and utilization of insoluble matter in nature" is the strange title of an even stranger article by I. Mandl and C. Neuberg. This chapter is a cursory survey of soluble metal complexes of such substances as nucleic acid, ATP, uronic acids, amino acids, and proteins. The significance of much of this to biology is not clear in spite of the authors' conclusion that "All solubilizing agents are of the utmost biochemical importance."

Wainio and Cooperstein in discussing "Some controversial aspects of the mammalian cytochromes" have uncovered plenty of controversy in 367 references and deliberately leave both the field and the reader in an unsettled condition. "Metabolic aspects of chemical genetics" by A. G. De Busk is a superficial summary of a much reviewed subject. This chapter might have been improved by restricting the field of coverage and by careful editing. The last chapter on "Ribonucleic acids and virus multiplication" by R. Jeener is a timely review of the significance of RNA in plant virus growth. The editor has made a worth-while selection in eight of ten chapters, far more than enough to justify publication of this volume.

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Anatomy of the Honey Bee. R. E. Snodgrass. Comstock (Cornell University Press), Ithaca, N.Y., 1956. xiv + 334 pp. $6.

This book gives a detailed analysis of the gross structure of the adult bee. Most of the topics have a brief comparative introduction, and there is adequate consideration of development, histology, and the functional aspects of anatomy. The writing is clear and well organized.

Although essentially a new book, this is well based on the author's earlier publications, which extend back to 1910. His *Anatomy and Physiology of the Honeybee* (1925) was about the same size as the present book, but Snodgrass now leaves most of the physiology to specialists and has omitted most of the biology and behavior, with bows to the recent books of von Frisch, Ribbands, and Butler. Since 1925 our knowledge of the anatomy of the honeybee has had major additions (many of them by Snodgrass himself) and some subtractions. The most obvious additions to this book are in musculature and endocrine organs. Two-thirds of the references given are to material published since 1925, and the early ones have been carefully winnowed.

Illustrations are the most significant feature of any treatise on anatomy, and here one must admire the precision and elegance of the pen work. Few of the many figures are completely new in this volume, but whether they are well redrawn from recent publications, diagrammatized, or borrowed from the author's early publications, they give constant evidence of Snodgrass' critical judgment. Even excellent drawings have been slightly reworked; figures have been regrouped; and the labels have been punctiliously revised to conform to changed concepts of homology. The ample letter labels are abbreviations probably recognizable to an entomologist. However, the key to these letters comes at the end of the chapter, and this makes it difficult for a beginner who may want to study a figure before the text.

The index is awkwardly analytic rather than primarily alphabetic; it does little more than the table of contents.

This will be a fundamental reference book, and an excellent textbook and manual for advanced students.

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New Books

Learning and Instinct in Animals. W. H. Thorpe. Harvard University Press, Cambridge, Mass., 1956. 493 pp. $10.

Aquatic Insects of California. With keys to North American genera and California species. Robert L. Usinger. University of California Press, Berkeley, 1956. 508 pp. $10.

Coal-Mining. I. C. F. Statham. Philosophical Library, New York, 1956. 564 pp. $15.

A Life of Sir William Ramsay. Morris W. Travers. Arnold, London, 1956. 308 pp. $12.50.

Modern Views on the Secretion of Urine. Cushny Memorial Lectures. F. R. Winton, Ed. Little, Brown, Boston, 1956. 292 pp. $8.50.

Mathematics for Electronics, with Applications. Henry M. Nodelman and Frederick W. Smith. McGraw-Hill, New York, 1956. 391 pp. $7.

Fine Structure of Cells. A symposium held at the 8th Congress of Cell Biology, Leiden, 1954. Union Internationale des Sciences Biologiques; Interscience, New York, 1956. 321 pp. $8.50.

Scientific Serials. Characteristics and lists of most cited publications in mathematics, physics, chemistry, geology, physiology, botany, zoology, and entomology. ACRL Monogr. No. 16. Charles Harvey Brown. Association of College and Reference Libraries, Chicago, 1956. 189 pp. $4.25.

Family Medical Costs and Voluntary Health Insurance: A Nationwide Survey. Odin W. Anderson with Jacob J. Feldman. Blakiston Div., McGraw-Hill, New York, 1956. 251 pp. $6.50.

Theory and Dynamics of Grassland Agriculture. Jack R. Harlan, Van Nostrand, Princeton, N.J., 1956. 281 pp. $6.75.

Seamanship. T. F. Wickham. Philosophical Library, New York, 1956. 192 pp. $3.75.

Process Chemistry. F. R. Bruce, J. M. Fletcher, H. H. Hyman, J. J. Katz. McGraw-Hill, New York; Pergamon, London, 1956. 407 pp. $12.

Irrigation Engineering. vol. II, *Projects, Conduits, and Structures.* Ivan E. Houk. Wiley, New York; Chapman & Hall, London, 1956. 531 pp. $14.

Margarine and Other Food Fats. Their history, production and use. M. K. Schwitzer. Interscience, New York, 1956. 385 pp. $7.

Matrix Calculus. E. Bodewig. North-Holland, Amsterdam; Interscience, New York, 1956. 334 pp. $7.50.

Nerve Impulse. Transactions of the Fifth Conference, 20–22 Sept. 1954, Princeton, N.J. David Nachmansohn and H. Houston Merritt. Josiah Macy, Jr. Foundation, New York, 1956. 256 pp. $4.50.

Group Processes. Transactions of the Second Conference, 9–12 Oct. 1955, Princeton, N.J. Bertram Schaffner, Ed. Josiah Macy, Jr. Foundation, New York, 1956. 255 pp. $3.50.

The Push-Button World. Automation today. E. M. Hugh-Jones, Ed. University of Oklahoma Press, Norman, 1956. 158 pp. $3.75.

Clinical Chemistry, Principles and Procedures. Joseph S. Annino. Little, Brown, Boston, Mass., 1956. 280 pp. $7.50.

Body Measurements and Human Nutrition. Josef Brožek, Ed. Wayne University Press, Detroit, 1956. 167 pp. $3.50.

Progress in Cosmic Ray Physics. vol. III. J. G. Wilson, Ed. North-Holland, Amsterdam; Interscience, New York, 1956. 420 pp. $10.50.

Fundamentals of Chemistry and Applications. Chosen from inorganic, organic and biochemistry, with applications in physiology, microbiology, nutrition, and everyday concerns. Charlotte A. Francis and Edna C. Morse. Macmillan, New York, ed. 4, 1956. 543 pp. $6.

Aerodynamics, Propulsion, Structures and Design Practice. vol. II of *Principles of Guided Missile Design.* Van Nostrand, Princeton, N.J., 1956. 595 pp. $10.

Legg-Calvé-Pethes Syndrome and Related Osteochondroses of Youth. Charles W. Goff in association with Ned M. Shutkins and Myerma R. Hersey. Thomas, Springfield, Ill., 1954. 332 pp. $10.75.

Foundations of the Theory of Probability. A. N. Kolmogorov. Translation edited by Nathan Morrison. Chelsea, New York, English ed. 2, 1956. 84 pp. $2.50.

Evolution: The Ages and Tomorrow. G. Murray McKinley. Ronald Press, New York, 1956. 275 pp. $4.

Jenaer Jahrbuch 1955. Carl Zeiss Jena. Fischer, Jena, 1955. 150 pp. DM. 14.

Handbook of Histology (Formerly *Handbook of Microscopic Characteristics of Tissues and Organs*). Karl A. Stiles, Blakiston Div., McGraw-Hill, New York, ed. 4, 1956. 240 pp. $3.

Progress in Nuclear Energy. Series II, *Reactors.* R. A. Charpie, D. J. Hughes, D. J. Littler, M. Trocheris, Eds. McGraw-Hill, New York; Pergamon, London, 1956. 492 pp. $14.

An Introductory Course in College Physics. Newton Henry Black and Elbert Payson Little. Macmillan, New York, ed. 4, 1956. 786 pp. $6.75.

Air Pollution Handbook. Paul L. Magill, Francis R. Holden, Charles Ackley, Eds. McGraw-Hill, New York, 1956. 720 pp. $15.

Elements of X-Ray Diffraction. B. D. Cullity. Addison-Wesley, Reading, Mass., 1956. 514 pp. $10.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

A Classificational Catalog of the Meteoritic Falls of the World. Frederick C. Leonard. University of California Press, Berkeley, 1956. 79 pp. $1.75.

The Culture and Acculturation of the Delaware Indians. Anthropological Papers, Museum of Anthropology, University of Michigan, No. 10. William W. Newcomb, Jr. University of Michigan, Ann Arbor, 1956. 141 pp. $2.

Histology of the Ovary of the Adult Mealworm Tenebrio Molitor L. (Coleoptera, Tenebrionidae). University of California Publ. in Entomology, vol. 11, No. 6. Loren L. Schlottman and Philip F. Bonhag. 44 pp. $0.75. *Responses of Vegetation to Fire.* A study of herbaceous vegetation following chapparral fires. University of California Publ. in Botany, vol. 28, No. 4. James R. Sweeney. 108 pp. $2. University of California, Berkeley, 1956.

Organization of the Federal Government for Scientific Activities. 349 pp. $1.75. *Federal Support for Science Students in Higher Education.* 33 pp. $0.30. National Science Studies. National Science Foundation, Washington 25, 1956 (order from Supt. of Documents, GPO, Washington 25).

Education for National Survival. A handbook on civil defense for schools. 88 pp. $0.65. *Pupil Transportation Responsibilities and Services of State Departments of Education.* Misc. No. 27. E. Glenn Featherston and Robert F. Will. 39 pp. $0.35. U.S. Office of Education, Washington, 1956 (order from Supt. of Documents, GPO, Washington 25).

The Year Book of the International Council of Scientific Unions 1956. Secretary-General, ICSU, c/o Royal Society, Burlington House, Piccadilly, London, W.1. 83 pp. 5s.

Gladys A. Reichard. A booklet published by Barnard College in memory of Gladys A. Reichard. Barnard College, New York, 1956. 32 pp.

Study on the Use of Science Counselors. Science Teaching Improvement Program, American Association for the Advancement of Science, Washington, 1956. 16 pp.

Symposium on the Role of Some of the Newer Vitamins in Human Metabolism and Nutrition. Proceedings of the Nutrition Symposium held at Vanderbilt University School of Medicine, Nashville, Tennessee, 20–21 Oct. 1955. Nutrition Symposium Ser. 12. National Vitamin Foundation, New York 22, 1956. 137 pp. $2.50.

Thirty-Ninth Annual Report of the National Research Council of Canada 1955–56. N.R.C. 3970. National Research Council of Canada, Ottawa, 1956. 50 pp.

Flexible Culverts under High Fills. Highway Research Bd. Bull. 125. National Academy of Sciences–National Research Council, Washington, 1956. 177 pp. $3.30.

Fossil Tubulidentata from East Africa. Fossil Mammals of Africa, No. 10. D. G. MacInnes. 38 pp. £1. *The Evolution of Ratites.* Bull., zoology, vol. 4, No. 2. Gavin de Beer. 14 pp. 10s. *A Preliminary Revision of the Family Trichiuridae.* Studies on the Trichiuroid Fishes—3. Bull., zoology, vol. 4, No. 3. Denys W. Tucker. 57 pp. £1. British Museum (Natural History), London, 1956.

Television in Our Schools. Bull. 1952, No. 16, revised 1956. Franklin Dunham and Ronald R. Lowdermilk. U.S. Office of Education, Washington, 1956 (order from Supt. of Documents, GPO, Washington 25). 38 pp. $0.20.

Teacher Exchange Opportunities and Summer Seminars. For American elementary, secondary, and junior college teachers under the International Education Exchange Program, 1957–58. U.S. Office of Education, Washington, 1956. 15 pp.

Radar-Synoptic Analysis of Hurricane Edna, 1954. Geophysical Research Papers No. 50. Edwin Kessler, III, and David Atlas. Geophysics Research Directorate, Air Force Cambridge Research Center, Bedford, Mass., 1956 (order from U.S. Department of Commerce, Office of Technical Services, Washington 25). 113 pp.

Basic Mechanisms in Radiobiology. pt. IV. *Cellular Aspects.* Nuclear Science Ser. Rept. No. 18. Harvey M. Patt and E. L. Powers, Eds. National Academy of Sciences–National Research Council, Washington, 1956. 190 pp.

Mesoamerican Notes. No. 4. Dept. of Anthropology, Mexico City College, Mexico, D.F. 92 pp. $1.50.

Alcoa Aluminum Handbook. Aluminum Company of America, Pittsburgh, Pa., 1956. 175 pp.

Role Conflict and Instructor Effectiveness at the Air Command and Staff School. AFPTRC-TN-56–41. Jacob W. Getzels and Egon G. Guba. 99 pp. *Development of an Interview Procedure for USAF Officer Applicants.* AFPTRC-TN-56-43. Michael A. Zaccaria *et al.* 29 pp. *Comparison of Performance upon the E-4 Fire Control System Simulator and Upon Operational Equipment.* AFPTRC-TN-56-47. Guy G. Besnard and Leslie J. Briggs. 15 pp. *Development of Motivation Keys for the Armed Forces Qualification Test Forms 3 and 4.* AFPTRC-TN-56-60. Jane McReynolds. 16 pp. *The Construction of Spatial Orientation Items by Means of a Cyclorama.* AFPTRC-TN-56-61. Frederick B. Davis. 16 pp. *The Airmen's Proficiency School: An Approach to the Problem of Adaptation and Motivation in the Air Force.* AFPTRC-TN-56-57. Carson Y. Nolan, Forrest R. Ratliff, Harold W. Richey. 11 pp. Air Force Personnel & Training Research Center, Lackland Air Force Base, San Antonio, Texas, 1956.

National Tuberculosis Association, Annual Report, Apr. 1955–Mar. 1956. The Association, New York, 1956. 40 pp.

Meetings and Societies

Plant Protection

The second international Plant Protection Conference, sponsored by Plant Protection, Limited, was held in England on 18–21 June 1956. Attending were some 200 delegates representing 42 lands and countries. The conference, under the general chairmanship of E. M. Fraser (U.K.), opened with a luncheon at the Dorchester Hotel at which the principal speaker was R. A. Butler, Lord Privy Seal. Butler expressed the view that this type of international conclave of scientists is more effective in promoting international accord than any other type of international meeting. He pointed out that, although plant protection research is generally underestimated by the public, it is nonetheless indispensable to protect the food sources for the world's expanding population.

Following the luncheon, the delegates repaired to the thoroughly congenial setting of the Fernhurst Research Station, Surrey, for detailed considerations of the various scientific aspects of crop protection.

The world aspects of crop protection were introduced by Sir Frank Engledow (U.K.). H. J. Page (U.K.) delivered the principal paper by J. G. Knoll (FAO), which described the history of international cooperation, recent international spread of pests and diseases, and the current international activities of FAO.

The role of genetics in crop protection was chairmaned by S. C. Harland (U.K.). W. F. Hanna (Canada) described the importance of resistant plant varieties to insects and disease, especially from the background of rust-resistant varieties of wheat. He commented on the vast number of biotypes of common pathogenic fungi and contrasted the ease with which strains have developed to overcome resistant host varieties, with the singular lack of demonstrated pathogen resistance to chemicals. This provoked considerable discussion, during which it was concluded that resistant strains of fungi have not been intensively looked for and that most fungicides are general protoplasmic poisons which reduce the likelihood of selection for resistance. K. T. Suhorukov (U.S.S.R.) described the plant physiological aspects of resistant varieties, and R. L. Knight summarized the results of 15 years of research on the genetics of resistance to black arm disease of cotton.

The session on mechanisms of toxicity was chairmaned by Sir Rudolph Peters (U.K.). S. E. A. McCallan (U.S.A.) discussed the mode of action of fungicides and pointed out that present-day fungicides generally lack specific action and are relatively ineffective by comparison with other classes of biocides. J. W. L. Beament (U.K.) emphasized the difficulties in correlating the highly specific biochemical action of most insecticides with the physiological complexity of the living systems through which they must pass to the site of action, and J. T. Martin (U.K.) described the physicochemical problems involved in bringing pesticides into contact with disease organisms—that is, the nature, distribution, and behavior of deposits. He concluded that because of inefficient distribution methods many crop protection chemicals are being applied at unnecessarily high dosages and that better methods of application will permit the use of expensive chemicals with particularly favorable action and will minimize the hazards of mammalian and plant toxicity. Much of the discussion of these papers was related to the problems of the *in vivo* transformation of pesticides such as schradan, parathion, dithiocarbamates, and fluoroacetate to more active toxicants.

Three papers on the role of systemic pesticides in crop protection—insecticides (R. L. Metcalf, U.S.A.), fungicides and bactericides (P. W. Brian, U.K.), and herbicides (E. Åberg, Sweden)—were introduced by T. A. Bennet-Clark (U.K.). The speakers emphasized the complexity of the behavior of these substances, their importance as selective agents to supplement biological control, and the question of *in vivo* modifications of the toxicants to substances of greater or lesser activity. Additional points of interest were the use of systemic insecticides as seed treatments to protect seedling crops and for the control of insect vectors of plant diseases; the possibilities of downward-translocating systemic fungicides for root protection; and the rotation of selective herbicides to prevent development of plant resistance.

The session devoted to the assessment of the residual effects of crop-protection chemicals was primarily concerned with human health hazards. J. M. Barnes (U.K.) discussed the problems of handling toxic chemicals during crop application and stated that the simple measure of thorough washing with soap and water after pesticide application is the most valuable safeguard against human poisoning. Apart from the well-recognized hazards of the use of organo-phosphorus insecticides and dinitro-*ortho*-cresol, pentachlorophenol and the alkylated mercurial fungicides were mentioned as materials for which suitable precautions in handling are necessary. R. Truhaut (France), in a paper by D. R. Fabre and Truhaut, discussed the problems of the residue hazards associated with the use of pesticides on foodstuffs. These may be limited by determining maximum tolerable concentrations, such that levels 100 times as great produce no serious ill effects in laboratory animals over several generations, and by restricting treatment to prescribed periods before harvest. The safety standards or tolerances proposed by the Western European Union were compared with those of the U.S. Food and Drug Administration. The authors felt that particular emphasis should be given to possible carcinogenic action of proposed pesticides. F. J. D. Thomas (Australia) described the residual effects of pesticides applied to the soil. Acute problems here are interference with plant germination or growth, tainting crops, or interfering with beneficial soil organisms. The author concluded that, although short-term tainting from BHC and possible long-term accumulation of DDT may result from injudicious usage, there is currently little evidence of serious soil poisoning from pesticides. Continued vigilance should be exercised over both old and new chemicals, so that any developing residue troubles may be foreseen and corrective steps may be taken.

The discussion of the application of crop-protection chemicals was chairmaned by W. C. Moore (U.K.). The mechanics of spray production were dealt with very thoroughly by R. P. Fraser (U.K.) and illustrated with beautiful high-speed photographs and motion pictures clearly showing that the mechanism of disintegration of liquid sheets results from unstability, producing filamentation followed by breakup of the filaments. E. W. B. van den Muijzenberg (Holland) illustrated the advantages of mist blowers in orchard spraying which results in marked savings of pesticide and labor. He described an electronic drop counter for rapid assessment of the perimeters of spray clouds. R. C. Rainey (U.K.) emphasized the necessity for thoroughly understanding the relevant

aspects of locust behavior in efficiently attacking swarms of desert locusts by aircraft spraying.

The proceedings concluded with a comprehensive exhibit and demonstration of crop-protection machinery chairmaned by S. P. Stotter (U.K.) and a buffet supper at which E. Holmes (U.K.) briefly summarized the conference.

This conference was notable for the breadth of scientific disciplines represented, the opportunities for discussion on a truly international basis, and the perfection of arrangements and elegance of amenities. Especially noteworthy were the availability of printed prepublication copies of all papers and the use of closed-circuit television for illustrations. The delegates departed not only with a thorough sense of physical well-being but also with sober reflections regarding the manifold imperfections of current plant-protection knowledge and practices. The papers and recorded discussions are soon to be published by Plant Protection, Limited.

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Pacific Division Meets

The 37th annual meeting of the Pacific Division, American Association for the Advancement of Science, was held at the University of Washington, Seattle, 11–16 June 1956. Twenty-three societies participated in the meeting, at which 500 scientific papers were presented.

Arrangements for the meeting were efficiently handled by a local committee and various subcommittees, under the general chairmanship of E. C. Lingafelter (department of chemistry, University of Washington). Registration and information headquarters were located in the Student Union Building, which also housed an interesting and instructive collection of commercial exhibits.

The committees on arrangements made it possible for the guests to enjoy to full advantage the remarkable scenic attractions that Seattle has to offer. They must have gone so far as to conspire with the Weather Bureau. And even the salmon were biting in Puget Sound. Tours were arranged to the Snoqualmie Falls Forest Camp, to Paradise Valley in Mount Rainier National Park, and to the Friday Harbor Laboratories of the University of Washington in the San Juan Islands. Special excursions were also planned so that interested persons could visit the San Juan Fishing and Packing Company of Seattle and the Boeing Airplane Company's Plant II.

A number of social events were held, including a general reception by President Henry Schmitz of the University of Washington and Mrs. Schmitz, two evening hours, a ladies' tea, and a salmon barbecue dinner at Seward Park on the shore of Lake Washington.

There were three general evening sessions. On Monday evening, 11 June, Walter G. Whitman (Massachusetts Institute of Technology), president of the American Institute of Chemical Engineers, spoke on "The significance of the Geneva atoms-for-peace conference." On Tuesday evening, the address by Robert B. Brode (University of California, Berkeley), president of the Pacific Division, AAAS, dealt with "The boundaries of science." The concluding address on Wednesday evening was by N. Tinbergen (Oxford University, Walker-Ames professor of zoology, University of Washington), who spoke on "Experiments on adaptive coloration in animals."

At the meeting of the council on Wednesday afternoon, Ian Campbell (California Institute of Technology) was named president-elect of the Pacific Division. The president of the division for the coming year is J. Murray Luck (Stanford University). Elected to membership on the executive committee were Walter P. Cottam (Department of botany, University of Utah) and George A. Bartholomew (department of zoology, University of California, Los Angeles). Elected to the council were J. G. Hooley (department of chemistry, University of British Columbia) and Theodore L. Jahn (department of zoology, University of California, Los Angeles).

Representing the national administration of the AAAS at the meeting were Thomas Park of the University of Chicago, who came as a representative of the president of the AAAS, Paul B. Sears, and Raymond L. Taylor, associate administrative secretary.

Societies meeting in conjunction with the Pacific Division were American Chemical Society (Pacific Northwest Regional Meeting), American Institute of Chemical Engineers (Washington-Oregon Section), American Meteorological Society (national meeting), American Nature Study Society (Western Division), American Phytopathological Society (Pacific Division), American Society for Horticultural Science (Western Region), American Society of Ichthyologists and Herpetologists (Western Division), American Society of Limnology and Oceanography (Pacific Section), American Society of Plant Physiologists (Western Section), Association of Pacific Coast Geographers, Biometric Society (Western North American Region), Botanical Society of America (Pacific Section), Cooper Ornithological Society (Northern Division), Ecological Society of America (Western Section), Herpetologists League, National Association of Biology Teachers, Pacific Northwest Bird and Mammal Society, Pacific Slope Biochemical Conference, Society for Experimental Biology and Medicine (Pacific Coast Section), Society of Systematic Zoology (Pacific Section), Western Bird-Banding Association, Western Society of Naturalists, Western Society of Soil Science.

The 1362 registered members and guests attending the meeting were drawn from a wide geographic area, as is shown in Table 1. Included in the total registration and breakdown by states are 402 chemists and chemical engineers, most of whom preregistered separately. Sev-

Table 1. Geographic distribution of registrants*

Arizona	4	Ohio	1	Canada	
California	*307*	Oklahoma	1	Alberta	1
Colorado	3	*Oregon*	*155*	*British Columbia*	*88*
Connecticut	2	Rhode Island	1	Quebec	1
District of Columbia	4	Tennessee	1	Saskatchewan	2
Idaho	*12*	Texas	1	Egypt	1
Illinois	6	*Utah*	*39*	England	2
Maryland	2	Virginia	3	*Hawaii*	*8*
Michigan	1	*Washington*†	*664*	India	5
Missouri	2	Wisconsin	2	Iran	1
Montana	*12*	Wyoming	1	Israel	1
Nebraska	5			Jordan	1
Nevada	*0*	Total, continental United States	1241	Netherlands	2
New Jersey	2			Norway	1
New Mexico	1	Alaska	2	Spain	1
New York	8	Australia	2	Thailand	1
North Carolina	1	Austria	1		
				Total, territorial and foreign	121
				Grand total	1362

* Italics indicate the seven states, the Territory of Hawaii, and the Canadian province of British Columbia that comprise the area of the Pacific Division of the AAAS. Their combined registration was 1285, or 94 percent of the total.
† There were 34 communities in Washington represented, including 460 from Seattle and 106 from Pullman.

eral other societies maintained individual registrations and, although many of their members also registered with the AAAS, it is possible that the aggregate nonduplicate registrations in Seattle may have totaled 1550—making this one of the largest meetings of the Pacific Division.

The next annual meeting of the Pacific Division will be held at Stanford University, 25–29 August 1957, in connection with the national meeting of the American Institute of Biological Sciences to be held at Stanford at that time.

ROBERT C. MILLER
California Academy of Sciences, San Francisco

Aging

Health for the aging was the subject of the ninth annual University of Michigan Conference on Aging, which was held 9–11 July in Ann Arbor. Of interest to *Science* readers are the papers that were presented at the research seminar (Ralph W. Gerard, chairman) and at the two seminars on training. E. V. Cowdry was chairman of the group that discussed training in geriatrics, and Clark Tibbitts was chairman of the group concerned with professional training in gerontology. The more than 700 persons who registered at the conference were primarily attending 12 different workshops concerned with different facets of health and aging. The conference as a whole assembled for major addresses, such as those of Edward L. Bortz, "Healthy added years"; L. T. Coggeshall, "The battle against chronic disease"; William B. Kountz, "Current trends in gerontology"; and L. E. Burney, "Trends in health legislation." Two panel discussions were organized: "Applications to the health needs of older people," Wilbur J. Cohen, moderator; and "Meeting the costs of medical care of the older age group," Odin W. Anderson, moderator.

Twelve papers were presented in the research seminar. Gerard introduced the seminar and presented the basis for the order of presentation, which was to begin with cellular mechanisms of aging and to proceed through papers and discussion for 2 days, concluding with age changes in social behavior. Johan Bjorksten pointed out that one of the likely mechanisms of aging is immobilization of tissue proteins such as would occur as the result of irreversible cross-linkages. The concept of rigidity appeared as a useful term to apply to changes at the submicroscopic level and through all levels of organization. Increasing rigidity as a function of aging has different implications, however, for the different levels of organization—for example, cells, tissues, organs, organisms, social systems, and institutions. Because of the widely different implications, the usefulness of the term *rigidity* lies at present in its naturalistic aspects—that is, the ability of individuals and species to survive and prosper in changing habitats.

L. Frederick Bissell pointed out the difficulties of assessing diet in relation to aging and stressed the need for longitudinal research. Olaf Mickelsen also discussed nutrition and age changes in body composition. He pointed out that the fat content of the human body goes up with age, even with a constant body weight, and he described techniques that can be used to measure body fat. Joseph A. Falzone explained the fall in basal metabolic rate with age as a result of a widespread tendency for cells for the various tissues of the body to shrink and disappear. According to work reported by Reuben L. Kahn, there is some evidence that the ability of the body to produce antibodies declines with advancing age. The reticulo-endothelial system appears to decrease in function with age, as is shown by the fact that older persons show less response to a nonspecific test of antibody reaction. Numerous changes in the cells of the nervous system occur with age, but, because of the difficulties in obtaining and preparing suitable material, there is still uncertainty, according to Harry H. Wilcox, regarding exactly what the changes imply or how to distinguish them from disease and artifacts.

James E. Birren thought that the primary change in behavior with age was a slowing of skills and of speed of emergency reactions. He maintained that one of the important research questions at the moment is the extent to which slowness and rigidity of behavior is (i) the result of attitudes and (ii) the necessary result of the physiological and anatomical changes in the nervous system. L. Koyl described a research project in which he and his colleagues are attempting to find methods of assessing employability in aging persons and also to develop methods for studying the antecedents of later life pathology. This work is being carried out in a longitudinal study of a group of Canadian veterans.

In the discussion of social factors in aging, Gordon Streib pointed out that social power in our society tends to be concentrated in the older members. Although we do not have a gerontocracy, studies of communities show a concentration of decision making in the elders. Jack Weinberg viewed aging as a psychiatrist and emphasized that the great tragedy of aging is the gradual isolation that occurs since there is no replacement for the loss of job, family members, and friends. Hope is the necessary ingredient for successful aging. James Miller also discussed the psychiatric aspects of aging and drew analogies to physical systems; aging was viewed by him as in part a reduced energy output and a slower feedback.

What is the most effective way of training physicians to meet the health needs of older persons? This question was the subject of the seminar on training in geriatrics. The report of the seminar showed " . . . agreement as to the need and the desirability of stressing a program in schools of medicine for teaching, research and service on aging and the aged." Because of the practical problems of already crowded curricula the manner of introducing the subject matter of gerontology must rest with the faculties of the individual schools. "In view of the relatively small number of teachers qualified in the field of Gerontology it seems wise to establish graduate departments in selected medical schools. The functions of these departments would not be to turn out large numbers of graduates who could practice geriatrics as a specialty but to produce investigators and teachers in this field."

The seminar on professional training in gerontology approached its task by asking broad initial questions, such as "Whose responsibility is it to offer the education and training needed for work with the aging and aged?" and "Is there need for new courses, curricula, departments, field work experiences, degrees?" The seminar accepted the idea that students who will work primarily with older individuals within their professional fields should have preparation in gerontology and specialized courses within their own professions. Attempts were made to answer such questions as whose responsibility it is to initiate training, what kind of specialist is most needed, and what methods should be employed to train such persons. Three methods of initiating training were discussed: (i) specialization within an established graduate department, (ii) creation of a department or school of gerontology, and (iii) the creation of an institute of gerontology offering core courses, research opportunities, and field work.

The reports of the seminars and the research papers will be published by the University of Michigan. Further information may be obtained from Dr. Wilma Donahue, Chairman of the Division of Gerontology, University of Michigan.

JAMES E. BIRREN
Section on Aging, National Institute of Mental Health, National Institutes of Health, Bethesda, Maryland

Forthcoming Events

November

18–25. National Meeting of Surgeons, Mexico City, Mexico. (Intern. Acad. of Proctology, 147–41 Sanford Ave., Flushing, N.Y.)

19–20. Entomological Soc. of America, Eastern Branch, Atlantic City, N.J. (B. F. Driggers, Experiment Station, New Brunswick, N.J.)

21. Arctic Branch, Alaska Div., AAAS, College, Alaska. (Miss C. Juedes, Box 47, College.)

22–23. Calder Hall Nuclear Power Station, conf., London, England. (Secretary, British Nuclear Energy Conference, 1–7 Great George St., London, S.W.1.)

22–3. International Cong. of Industrial Chemistry, 29th, Paris, France. (J. Gerard, Société de Chimie Industrielle, 28, rue Saint-Dominique, Paris VII^e.)

23–24. American Mathematical Soc., Evanston, Ill. (E. G. Begle, 207 Leet Oliver Memorial Hall, Yale Univ., New Haven 11, Conn.)

23–24. American Physical Soc., Chicago, Ill. (K. K. Darrow, APS, Columbia Univ., N.Y. 27.)

23–24. American Soc. of Animal Production, annual, Chicago, Ill. (W. M. Beeson, Dept. of Animal Husbandry, Purdue Univ., W. Lafayette, Ind.)

24. American Ethnological Soc., New York, N.Y. (A. G. James, Hunter College, Bronx 68, N.Y.)

25–30. American Rocket Soc., annual, New York, N.Y. (J. J. Harford, ARS, 29 W. 39 St., New York 18.)

25–30. American Soc. of Mechanical Engineers, annual, New York, N.Y. (C. E. Davies, ASME, 29 W. 39 St., New York 18.)

26–28. American Soc. of Refrigerating Engineers, Boston, Mass. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)

26–30. Automation Exposition, 3rd intern., New York, N.Y. (TIAE, Richard Rimbach Associates, Inc., 845-A Ridge Ave., Pittsburgh 12, Pa.)

27–30. American Medical Assoc., clinical, Seattle, Wash. (G. F. Lull, AMA, 535 N. Dearborn St., Chicago 10, Ill.)

27–30. National Chemical Exposition, 9th, Cleveland, Ohio. (J. J. Doheny, NCE, 86 East Randolph St., Chicago 1, Ill.)

28–30. American College of Cardiology, 5th interim, Pittsburgh, Pa. (P. Reichert, ACC, Empire State Bldg., New York, N.Y.)

28–30. International Conf. on Ozone, 1st, Chicago, Ill. (C. E. Thorp, Armour Research Foundation, 35 W. 33 St., Chicago 16.)

29–30. Veterinary Symposium on "Meti-Steroids," New York, N.Y. (J. C. Siegrist, Schering Corp., Bloomfield, N.J.)

30. American Rheumatism Assoc., Bethesda, Md. (E.F. Hartung, 580 Park Ave., New York, N.Y.)

30–1. Oklahoma Acad. of Science, Stillwater. (D. E. Howell, Entomology Dept., Oklahoma A. & M. College, Stillwater, Okla.)

30–1. Tennessee Acad. of Science, Murfreesboro. (D. Caplenor, Dept. of Biology, Peabody College, Nashville 4, Tenn.)

December

2. American Acad. of Dental Medicine, 11th mid-annual, New York, N.Y. (A. Reiner, 114–01 201 St., St. Albans 12, N.Y.)

2–7. Radiological Soc. of North America, Inc., annual, Chicago, Ill. (D. S. Childs, 713 E. Genesee St., Syracuse 2, N.Y.)

5–7. Instrumentation Conf., 2nd, Inst. of Radio Engineers, Atlanta, Ga. (M. D. Prince, Engineering Experiment Station, Georgia Inst. of Technology, Atlanta.)

6. Amino Acid Imbalance in Nutrition, Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawe's Laboratories, Inc., 4800 S. Richmond St., Chicago 32.)

6–7. American Astronautical Soc., 3rd annual, New York, N.Y. (N. V. Petersen, AAS, 516 Fifth Ave., New York 36.)

6–8. American Phytopathological Soc., annual, Cincinnati, Ohio. (G. S. Pound, Dept. of Plant Pathology, Univ. of Wisconsin, Madison.)

6–9. American Psychoanalytic Assoc., New York, N.Y. (J. N. McVeigh, APA, 36 W. 44 St., New York 36.)

7–8. Association for Research in Nervous and Mental Disease, annual, New York, N.Y. (R. J. Masselink, 710 W. 168 St., New York 32.)

8–11. American Acad. of Optometry, annual, Houston, Tex. (C. C. Koch, 1506 Foshay Tower, Minneapolis 2, Minn.)

9–12. American Inst. of Chemical Engineers, annual, Boston, Mass. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York 36.)

9–12. American Soc. of Agricultural Engineers, Chicago, Ill. (J. L. Butt, ASAE, St. Joseph, Mich.)

10–12. American Nuclear Soc., winter meeting, Washington, D.C. (ANS, P.O. Box 963, Oak Ridge, Tenn.)

10–12. Eastern Joint Computer Conf., New York, N.Y. (J. R. Weiner, Remington Rand, Inc., 315 Fourth Ave., New York, N.Y.)

13–15. Texas Acad. of Science, annual, Brownwood, Tex. (G. C. Parker, Texas A.&M. College, College Station.)

19. Arctic Branch, Alaska Div., AAAS, College Alaska. (Miss C. Juedes, Box 47, College.)

26–31. American Assoc. for the Advancement of Science, annual, New York, N.Y. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., NW, Washington 5.)

The following 55 meetings are being held in conjunction with the AAAS annual meeting.

AAAS Academy Conference (L. Taylor, West Virginia Univ., Morgantown). 29–30 Dec.

AAAS Cooperative Committee on the Teaching of Science and Mathematics (M. Meister, Bronx High School of Science, New York 68). 27 Dec.

AAAS-Gordon Research Conferences (W. G. Parks, Univ. of Rhode Island, Kingston). 27 Dec.

Alpha Chi Sigma (H. G. Seavey, 30 Church St., Room 340, New York 7). 28 Dec.

Alpha Epsilon Delta (M. L. Moore, 7 Brookside Circle, Bronxville, N.Y.). 29 Dec.

American Assoc. of Clinical Chemists (A. E. Sobel, Jewish Hospital of Brooklyn, Brooklyn 16, N.Y.).

American Assoc. of Hospital Consultants (E. D. Barnett, School of Public Health, Columbia Univ., New York 32.)

American Assoc. of Scientific Workers (R. J. Rutman, 6331 Ross St., Philadelphia 44, Pa.). 29 Dec.

American Astronomical Soc. (J. A. Hynek, Harvard College Observatory, Cambridge 38, Mass.). 26–29 Dec.

American Documentation Inst. (J. Hilsenrath, National Bureau of Standards, Washington 25). 27–29 Dec.

American Educational Research Assoc. (A. G. Wesman, Psychological Corp., 522 Fifth Ave., New York 36). 29 Dec.

American Meteorological Soc. (R. J. Roth, Crop-Hail Insurance Actuarial Assoc., 209 W. Jackson Blvd., Chicago, Ill.). 28 Dec.

American Museum of Natural History (G. Reekie, AMNH, Central Park West at 79 St., New York, N.Y.). 26 Dec.

American Nature Study Soc. (R. L. Weaver, Univ. of Michigan, Ann Arbor). 26–30 Dec.

American Philosophical Assoc., Eastern Div. (J. Wild, Harvard Univ., Cambridge 38, Mass.). 27 Dec.

American Psychiatric Assoc. (B. Pasamanick, Ohio State Univ., Columbus 10). 28–29 Dec.

American Soc. of Hospital Pharmacists (G. E. Archambault, U.S. Public Health Service, Washington 25). 29 Dec.

American Soc. of Range Management (F. G. Renner, Soil Conservation Service, U.S. Dept. of Agriculture, Washington 25). 28 Dec.

American Statistical Assoc. (R. E. Johnson, Western Electric Co., New York 7).

Association for Computing Machinery (J. P. Nash, Univ. of Illinois, Urbana).

Association of American Geographers (P. M. Stern, Conservation Foundation, 30 E. 40 St., New York, N.Y.).

Astronomical League (H. B. Davidson, 812 Park Ave., New York 21.)

Conference on Scientific Editorial Problems (J. G. Adashko, Ford Instrument Co., Long Island City, N.Y.). 26–28 Dec.

Conference on Scientific Manpower (T. J. Mills, National Science Foundation, Washington 25). 26 Dec.

Ecological Soc. of America (M. F. Buell, Rutgers Univ., New Brunswick, N.J.). 26–30 Dec.

Entomological Soc. of America (P. W. Oman, Plant Industry Sta., Beltsville, Md.). 27–30 Dec.

Genetics Soc. of America (A. W. Pollister, Columbia Univ., New York 27). 28 Dec.

History of Science Soc. (Miss P. Kibre, Hunter College, New York, N.Y.). 27–29 Dec.

Institute of Mathematical Statistics (Miss E. Scott, Univ. of California, Berkeley 4).

International Council for Exceptional Children (M. H. Fouracre, Columbia Univ., New York 27). 26 Dec.

International Union for the Study of Social Insects, North American Section (T. C. Schneirla, American Museum of Natural History, Central Park West at 79 St., New York, N.Y.). 26–27 Dec.

Mountain Lake Biological Sta. (B. D. Reynolds, Univ. of Virginia, Charlottesville).

Mycological Soc. of America (L. S. Olive, Columbia Univ., New York 27). 26 Dec.

National Acad. of Economics and Political Science (D. P. Ray, George Washington Univ., Washington, D.C.). 27 Dec.

National Assoc. for Gifted Children (Miss A. F. Isaacs, 409 Clinton Springs Ave., Cincinnati, Ohio).

National Assoc. for Research in Science Teaching (N. Washton, Queens College, Flushing 67, L.I., N.Y.). 27 Dec.

National Assoc. of Biology Teachers (J. Breukelman, State Teachers College, Emporia, Kan.). 26–30 Dec.

National Assoc. of Science Writers (J. E. Pfeiffer, New Hope, Pa.).

National Geographic Soc. (W. R. Gray, NGS, 16 and M Sts., NW, Washington 6). 29 Dec.

National Speleological Soc. (Brother G. Nicholas, LaSalle High School, Cumberland, Md.). 29 Dec.

New York Acad. of Sciences (R. F. Nigrelli, New York Zoological Soc. and M. Kopac, New York Univ., Washington Sq., New York, N.Y.). 29 Dec.

Philosophy of Science Assoc. (C. W. Churchman, Case Inst. of Technology, Cleveland, Ohio), 29–30 Dec.

Pi Gamma Mu (B. H. Williams, Industrial College of the Armed Forces, Washington 25). 26 Dec.

Scientific Research Soc. of America (D. B. Prentice, Yale Univ., New Haven, Conn.). 26–27 Dec.

Sigma Delta Epsilon (C. Chandler, Boyce Thompson Inst. for Plant Research, 1086 N. Broadway, Yonkers 3, N.Y.).

Sigma Pi Sigma (M. W. White, Pennsylvania State Univ., University Park).

Society for the Advancement of Criminology (D. E. J. MacNamara, New York Inst. of Criminology, 2109 Broadway, New York, N.Y.). 29 Dec.

Society for the Advancement of General Systems Theory (L. von Bertalanffy, Mt. Sinai Hospital, Los Angeles 48, Calif.). 29–30 Dec.

Society for the Study of Evolution (H. Lewis, Univ. of California, Los Angeles 24). 27–29 Dec.

Society of General Physiologists (A. Shanes, National Institutes of Health, Bethesda, Md.).

Society of Systematic Zoology (R. E. Blackwelder, Box 500, Victor, N.Y.). 27–30 Dec.

Society of the Sigma Xi (T. T. Holme, Yale Univ., New Haven, Conn.). 27 Dec.

Society of Vertebrate Paleontology, annual (J. T. Gregory, Peabody Museum of Natural History, Yale Univ., New Haven, Conn.). 28–30 Dec.

Torrey Botanical Club (David Keck, New York Botanical Garden, Bronx Park, New York 58). 26–27 Dec.

United Chapters of Phi Beta Kappa (C. Billman, PBK, 1811 Q St., NW, Washington 6). 27 Dec.

27–28. Fluid Mechanics in Chemical Engineering, American Chemical Soc., Lafayette, Ind. (W. E. Ranz, Dept. of Engineering Research, Pennsylvania State Univ., University Park.)

27–28. Linguistic Soc. of America, Philadelphia, Pa. (A. A. Hill, Box 7790, University Sta., Austin 12, Tex.)

27–29. American Mathematical Soc., 63rd annual, Rochester, N.Y. (J. H. Curtiss, AMS, 80 Waterman St., Providence 6, R.I.)

27–29. American Physical Soc., Monterey, Calif. (W. A. Nierenberg, Univ. of California, Berkeley 4.)

27–29. Western Soc. of Naturalists, annual, Goleta, Calif. (D. Davenport, Santa Barbara College, Goleta.)

27–30. American Economic Assoc., annual, Cleveland, Ohio. (J. W. Bell, 629 Noyes St., Evanston, Ill.)

27–30. American Finance Assoc., annual, Cleveland, Ohio. (G. E. Hassett, Jr., New York Univ., 90 Trinity Place, New York 6.)

28. Society for the Advancement of Criminology, annual western, Fresno, Calif. (W. Dienstein, Fresno State College, Fresno.)

28–29. American Folk-Lore Soc., annual, Santa Monica, Calif. (MacE. Leach, Bennett Hall, Univ. of Pennsylvania, Philadelphia 4.)

28–30. American Anthropological Assoc., annual, Santa Monica, Calif. (W. S. Godfrey, Jr., Logan Museum, Beloit College, Beloit, Wis.)

28–30. American Historical Assoc., annual, St. Louis, Mo. (AHA, Study Room 274, Library of Congress, Washington 25.)

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123rd AAAS MEETING

New York City, December 26-31, 1956

The list of hotels and their rates and the reservation coupon below are for your convenience in making your hotel room reservation in New York. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in New York and thereby avoid delay and confusion. (Members of the American Astronomical Society who wish reservations at uptown hotels should correspond directly with the Hayden Planetarium.) The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less. **As in any city, single-bedded rooms may become scarce; double rooms for single occupancy cost more; for a lower rate, share a twin-bedded room with a colleague.** Most hotels will place comfortable rollaway beds in rooms or suites at 2.50 or 3.00 per night. Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Rates for Rooms with Bath*

All hotels have sessions in their public rooms. For a list of headquarters of each participating society and section, please see *Science,* July 20, or *The Scientific Monthly* for August.

Hotel	Single	Double Bed	Twin Bed	Suite
Governor Clinton	$7.00–11.00	$10.00–13.00	$11.00–17.00	$20.00–35.00
Martinique	5.00– 9.00	8.00–14.00	8.00–14.00	16.00–38.00
New Yorker	7.00–10.00	10.00–14.00	11.50–17.00	25.00 and up
Sheraton-McAlpin	6.75– 9.75	9.75–12.75	10.75–13.75	20.00 and up
Statler	8.00–12.00	11.00–15.00	11.50–18.00	31.00–33.00

* Subject to 5% New York City tax on hotel rooms.

THIS IS YOUR HOUSING RESERVATION COUPON

AAAS Housing Bureau
90 East 42nd Street
New York 17, N. Y.

Date of Application .....

Please reserve the following accommodations for the 123rd Meeting of the AAAS in New York City, Dec. 26–31, 1956:

TYPE OF ACCOMMODATION DESIRED

Single Room ..... Desired Rate ..... Maximum Rate .....

Double-Bedded Room ..... Desired Rate ..... Maximum Rate ..... Number in party .....

Twin-Bedded Room ..... Desired Rate ..... Maximum Rate .....

Suite ..... Desired Rate ..... Maximum Rate ..... Sharing this room will be:

(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)

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First Choice Hotel ..... **Second Choice Hotel** ..... **Third Choice Hotel** .....

DATE OF ARRIVAL ..... DEPARTURE DATE .....
(These must be indicated—add approximate hour, a.m. or p.m.)

NAME .....
(Individual requesting reservation) (Please print or type)

ADDRESS .....
(Street) (City and Zone) (State)

Mail this now to the Housing Bureau. **Rooms will be assigned and confirmed in order of receipt of reservation.**

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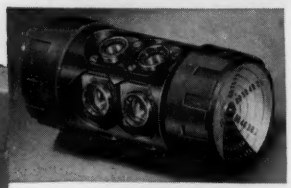

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